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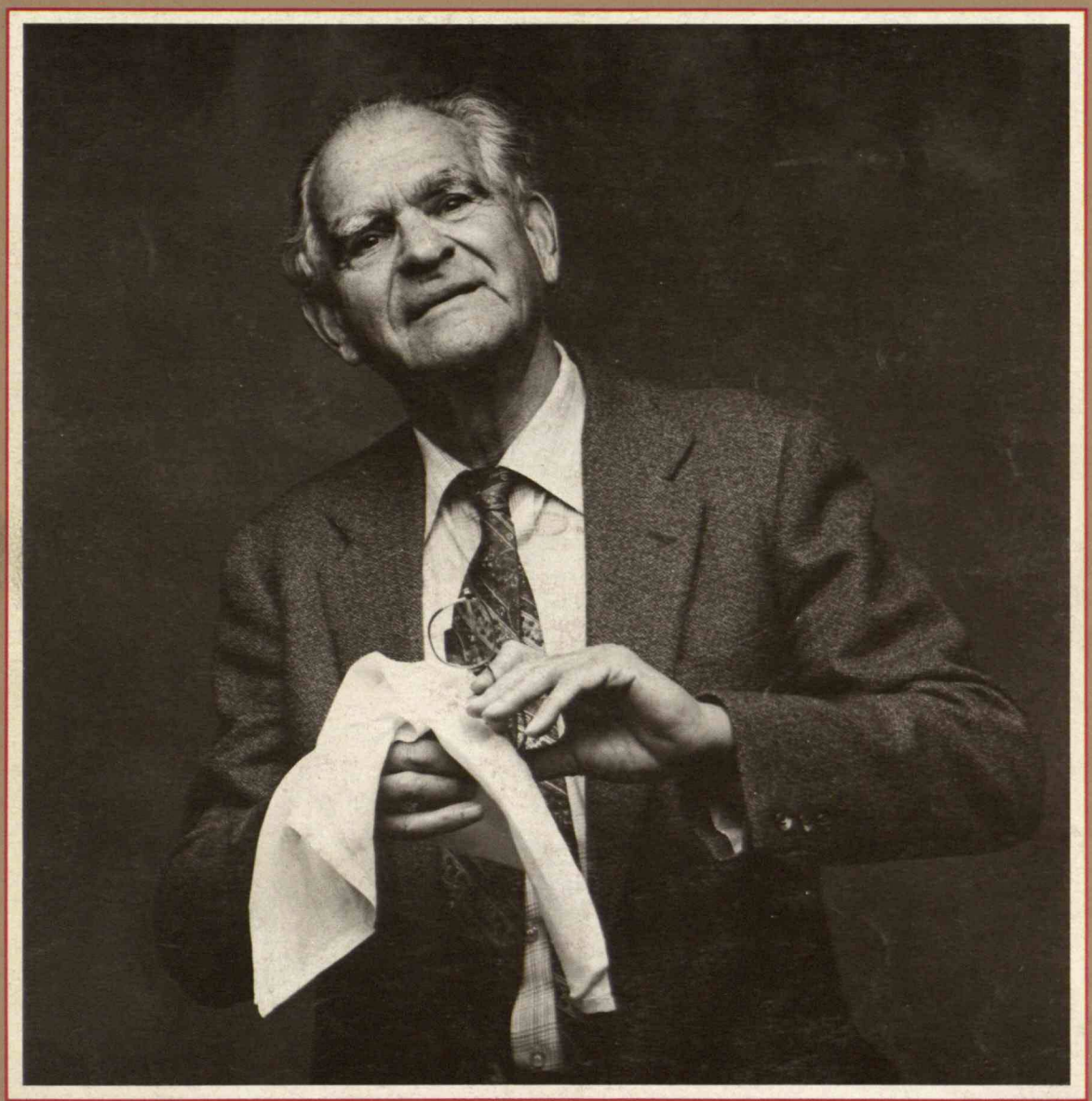
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Genetic Engineering:
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Technology Review

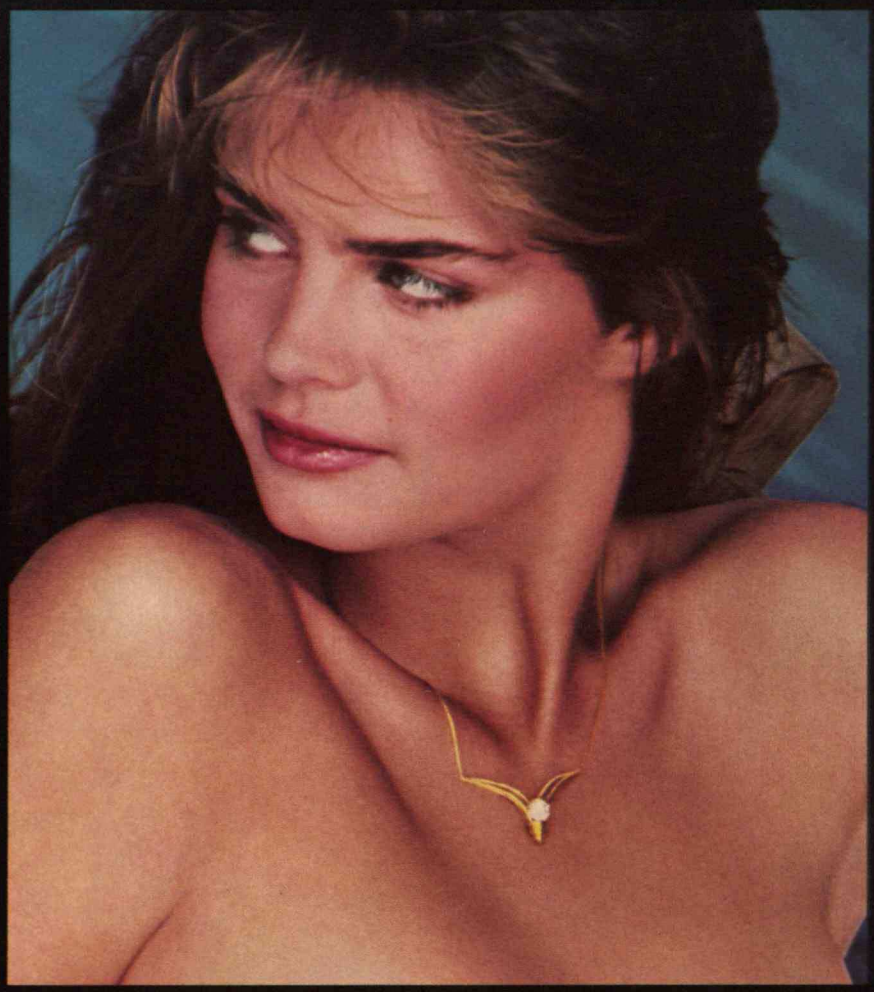
Edited at the Massachusetts Institute of Technology



The World According to Weisskopf

technology
review
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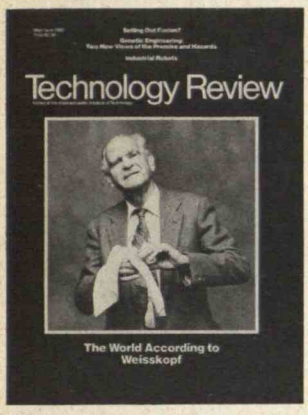
The one and a quarter carat diamond pendant shown is enlarged for detail.

A diamond is forever. De Beers

Edited at the Massachusetts Institute of Technology
Volume 85, Number 4
May/June 1982

Technology Review

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LETTERS

The Military's Inferiority-Superiority Complexes

Congratulations on another superb article on arms control, this time by Michael Johnson (*"Debunking the 'Window of Vulnerability,'" January, page 59*). Congratulations, too, on the courage to face this difficult and contentious subject.
Louis Sutro
Cambridge, Mass.

Michael Johnson's article is dangerous because it promotes complacency on the part of the American public. Prior to the Pearl Harbor attack and World War II, the American media assumed that no one would ever dare challenge the U.S. because we were so powerful, and Mr. Johnson is trying to tell us the same thing today. But the fact is that the Soviets are building a major military machine just as the Germans and Japanese did. Indeed, the Soviets are so bold as to tell us they intend to destroy us—and they do not mean by economic competition but by warfare.

Our greatest folly would be to fail to listen very carefully to that message and prepare thoroughly for its consequences. The only means we have of preventing World War III is to become so superior in arms that no one can challenge us.

The Soviets realize, as we do, that no one is going to win a nuclear war. This means especially that we must not let down our guard in so-called conventional weapons. Such an effort will require a heavy price, and we shall have to sacrifice many of the good things that make our life so pleasant and rewarding. My objection to Mr. Johnson's thesis is his denial of this necessity. One has merely to open his eyes to see that we live in a world of extreme danger, and that we must be completely prepared to deal with all facets of the situation. To avoid such measures is the height of folly.
Morris Guralnick
San Francisco, Calif.

The fundamental question posed by the Reagan administration's claim of a "window of vulnerability" is whether the Soviets can deliver a first strike of such magnitude that our nuclear retaliatory response is an ineffective deterrent. However, Michael Johnson does not discuss anything close to this. Instead, he addresses the issue of who has first-strike capability—a meaningless question since the United States presumably would not initiate a first strike.

In fact, the window of vulnerability exists in more ways than most of us may think. For example, it is well documented that the Soviets have been testing chemical and biological weapons in Southeast Asia, and all the missiles in the world could not prevent an enemy from smuggling canisters of these weapons into all our major cities. Our planners are concentrating on the modern equivalent of the Maginot line, a technological monument that our opponents will simply skirt.
W. Harry Vickers
Hollis, N.H.

In discussing the nonvulnerability of the American submarine force, Michael Johnson should have paid closer attention to the number of Polaris submarines. He incorrectly states that "at any one time, 22 to 25 of America's 31 Poseidon and 10 Polaris boats are 'on station,' carrying well over 3,000 warheads." In fact, 9 Polaris submarines have been converted to fast-attack submarines, while the tenth is undergoing the same process. In short, Polaris boats do not exist. This glaring oversight casts doubt on the validity of the other facts he presents. I am not convinced that American dominance over the Soviet Union is evident in almost every military area.
Peter Gunn
Niantic, Conn.

I register a strong protest against Michael Johnson's article:
☐ The U.S. fleet has 32, not 41, Polaris and Poseidon ballistic-missile submarines in operation (plus one newly commissioned Trident submarine). The remaining ballistic-missile submarines have either been decommissioned because of age or converted to other nonballistic roles.
☐ Though he asserts that the United States is in the process of achieving a first-strike capability against the Soviet Union, nowhere does Johnson describe how the United States can target and destroy the Soviet submarine-launched missile force. Without the ability to annihilate all Soviet strategic weapons systems simultaneously, a U.S. first-strike attempt would trigger disastrous retaliation.
☐ The article scoffs at the decision to build the B-1 bomber and provides no convincing argument that it is an unnecessary strategic weapons system. The latest version of the B-1 will have a radar cross-section less than 1 percent of the B-52, as well as more advanced electronic countermeasure capabilities. Also, the B-1 bomber will become airborne faster than the B-52 in the event of an alert.
(Continued on page 84)

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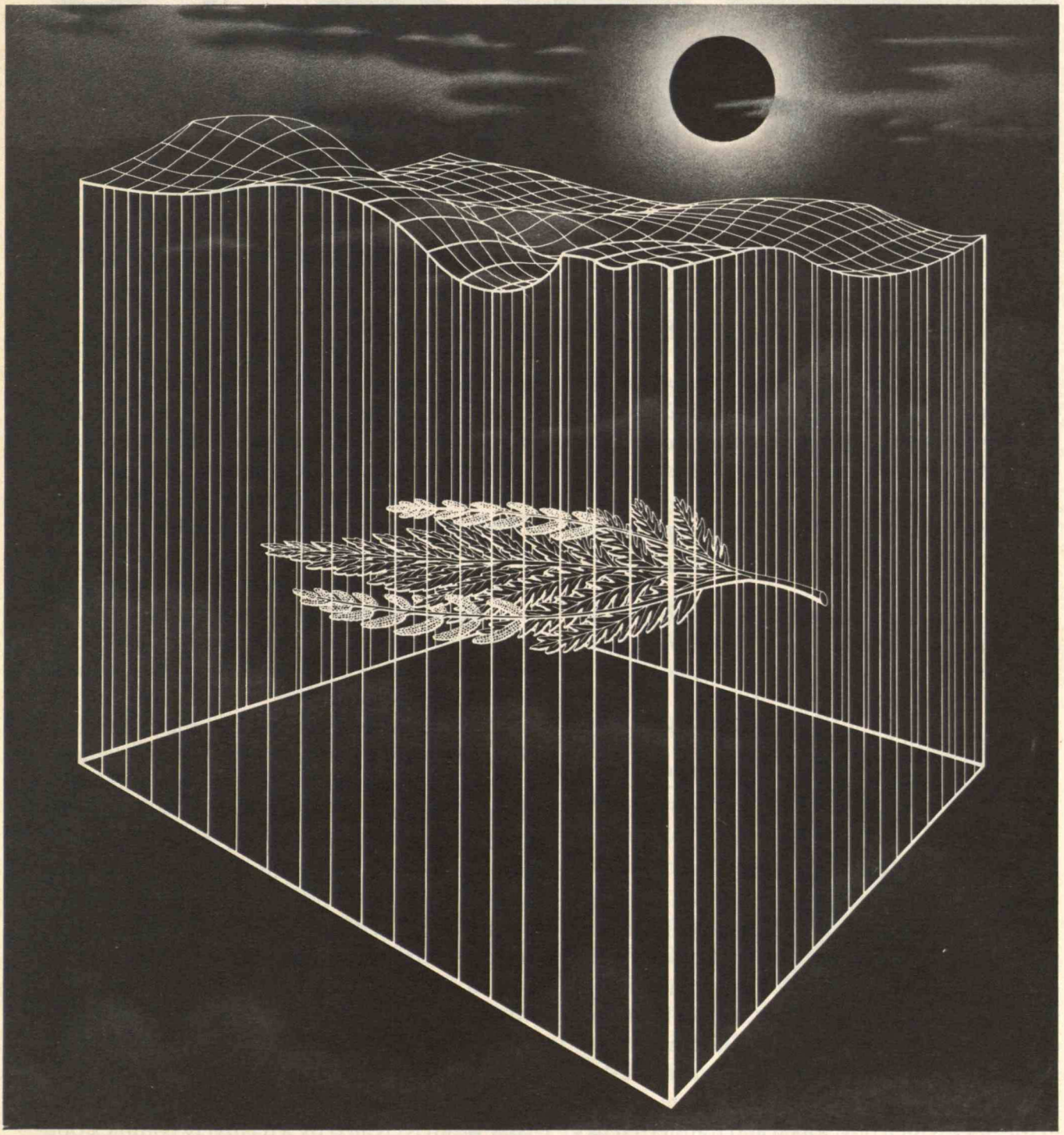
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THE LEADING EDGE

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Few inventions have proved more versatile than the laser.

It has been used as a super signal lamp for space communications. It has found a role in exotic metal-working applications, and the incredible precision that it offers has made new kinds of brain and eye surgery possible.

A system for playing TV shows from phonograph-like disks uses a laser to "read" the recorded program material.

Lasers are used in various forms of measurement and information handling systems. For example, one version of the bar-code reader used in supermarkets employs a laser scanner.

The Hologon Laser Scanner is one of the latest developments in practical applications of laser technology. It was invented by Xerox optical physicist Dr. Charles Kramer who wrote this article.

Lasers In Electronic Printing

At Xerox we use lasers in electronic printing systems that are based on xerography. Instead of making copies of existing documents, such printers create documents, drawing on information stored in a computer. In such a system, signals from the computer pulse the laser beam as it scans across a light-sensitive drum or belt that serves as the "camera film" in xerography. The image recorded in this way is then developed and transferred to paper as in a copier.

Laser electronic printers offer the quality of offset printing with significant versatility compared with conventional computer printers. There is virtually no meaningful limit to format or to type style or size. Pictorial or other graphic material can be printed as easily as text. Arabic, Greek or Russian alphabets—even Oriental ideograms—are within its capabilities, provided appropriate programming is fed into the printing system.

Equally significant is the fact that, with electronic printing, documents originated in one location can be printed simultaneously at a number of different locations.

Xerox currently offers three such systems. The 9700 electronic printing system turns out almost two pages per second and has almost unlimited flexibility when it is used with the Xerox Integrated Composition System program. The 5700 electronic printing system is up to 40 times faster than conventional word-processing printers, which it can replace, and it can also be used for electronic mail and remote computer printing. A similar printer is offered as part of the Xerox 8000 network system. Designed for lower-volume applications, it is twelve times faster than a conventional word-processing printer.

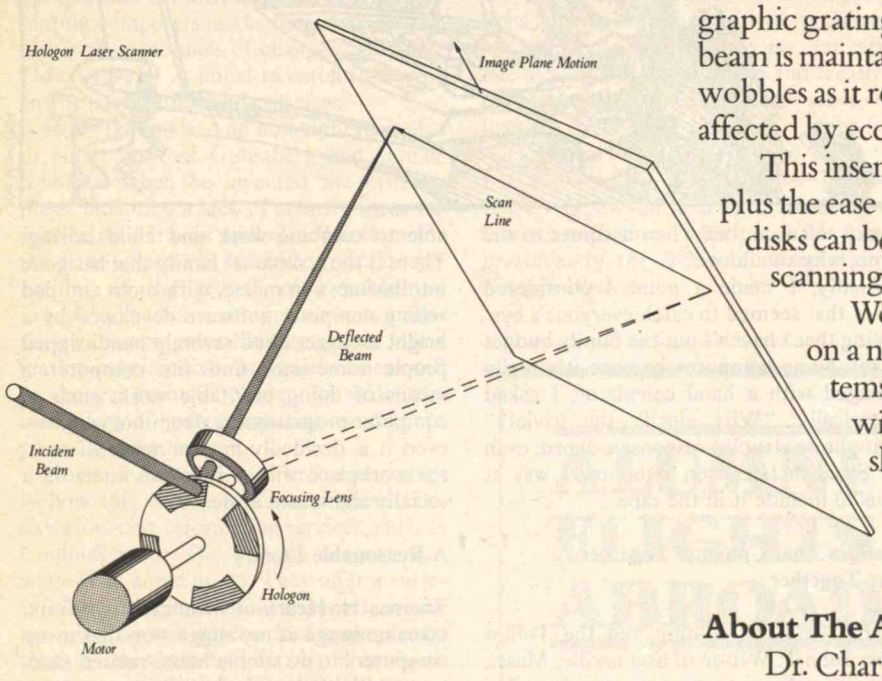
In these printers, the scanning action of the laser beam is created by a relatively complex opti-

cal system that is based on a rotating, polygonal prism. Extremely high precision is required in such a system. This complexity and precision make such a laser scanner relatively expensive.

The Hologon Laser Scanner

To simplify laser scanners and reduce their cost, we considered holography to perform the functions of costly lenses and prisms.

Holographic recordings, best known for their reproduction of three-dimensional images, take the form of gratings—corrugated or ridged patterns on a transparent medium, having a spacing of approximately twenty millionths of an inch. In pictorial holograms, these gratings contain the recorded cross section of the wavefront of light



that had been reflected from the pictorial subject. When coherent light—usually from a laser—is transmitted through such a hologram, a true three-dimensional image of the subject is reproduced.

However, the holographic gratings used in a Hologon scanning system do not contain pictorial information. Only the optical diffraction properties of the gratings are utilized.

The Hologon System is one of several holographic approaches to scanning. But the others tend to scan in an arc-like pattern which is unsuitable for electronic printing, which requires a straight-line scan, much like the raster pattern used in television to create an image. The Hologon approach gets around this problem through a novel configuration.

In a Hologon, a series of holographic gratings are formed around the circumference of a transparent disk. A laser shines through these gratings as the disk rotates. The gratings diffract the laser light, and the rotating action causes it to scan across the surface on which it is focused, as shown in the accompanying diagram. Focusing is done by a simple, inexpensive lens.

The laser beam in this system is aimed so that it forms a nominal 45° angle to the Hologon's surface as it enters a grating and a 45° angle as it emerges from the grating. In other words, it is diffracted through a right angle by the gratings. This angling results in a straight-line scan.

Because of the optical properties of the holographic gratings, the 90° diffraction angle of the beam is maintained even if the Hologon surface wobbles as it rotates. The beam angle is equally unaffected by eccentricities in the rotating disk.

This insensitivity to mechanical variation, plus the ease and low cost with which Hologon disks can be produced, make a Hologon laser scanning system relatively inexpensive.

Work is currently underway at Xerox on a new generation of laser printing systems utilizing the Hologon laser scanner with all its attendant benefits. This should enable Xerox to make the advantages of electronic printing more widely available than ever before.

About The Author

Dr. Charles Kramer is the inventor of the Hologon Laser Scanner. He is an optical physicist specializing in electro-optical reading and printing devices at the Xerox Joseph C. Wilson Center for Technology in Rochester, New York.



He holds a Bachelor's degree and a Master's degree in Physics from Fairleigh Dickinson University and a Master's degree and Ph.D in Optics from the University of Rochester.

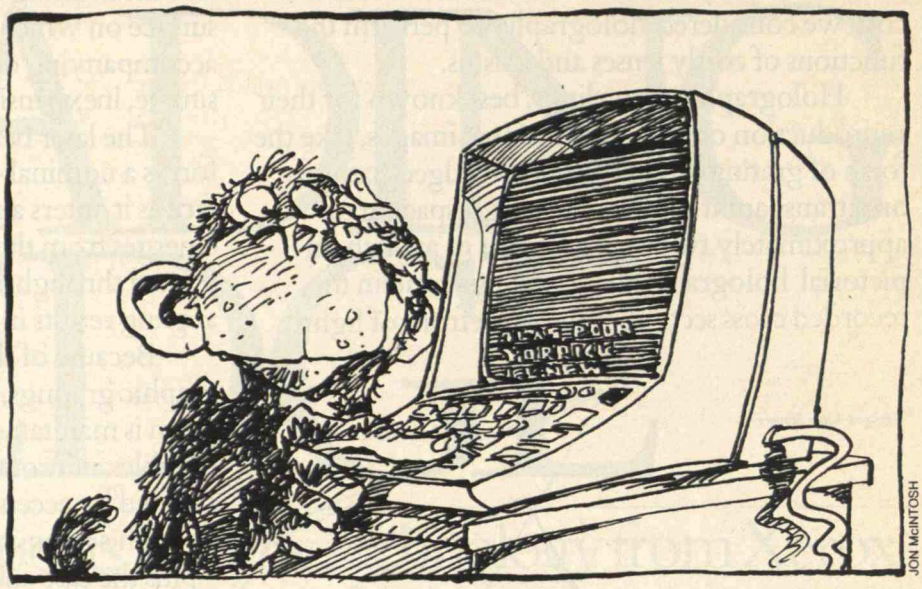
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Robert Cowen



Home Computing Revisited



ONE of the benefits of putting your thoughts in print is the interesting mail you receive. There are readers out there who care enough to put their own thoughts on paper and, perhaps, to challenge you—to say nothing of those who send an occasional nutty missive. Generally, if you're in the writing business, you take it all in stride, let the readers have their say in the letters column, and are quietly grateful that they took notice. It has always seemed to me a bit churlish for the writer to have the last word in one of those "editor's notes." But my column on home computers in the November/December issue generated such an intriguing and unusually vigorous response—including a request to repeat some of the points for Swedish television—that I'm breaking my vow of silence to respond to a few of the letters here.

The column appeared under the headline "Cottage Computing: Glorifying the Trivial?" It's a catchy phrase, which may help account for the response. But it only partly captures the points that were made.

I referred to Allan Toffler's concept of the "electronic cottage" as outlined in his book *The Third Wave*, in which he forecasts a major shift of the workplace from office and factory to the home. I deemed this unlikely in the foreseeable future given the crude state of home computing technology and related services, and the fact that relatively few jobs outside the information industry are adaptable to decentralized home production.

I noted that one has to be something of a computer buff, and at least a crude programmer, to run a home computer successfully, and that databases easily accessible by telephone at anything like a reasonable cost are rather unsatisfactory. This being the case, the home computer cannot yet justify its cost for most families—unless there is a definite need a computer could meet, such as professional work done at home or an educational opportunity for children (or adults) in families that could afford the expense.

I ended with the comment that one day there probably will be many imaginative and valuable uses for home computers, but, until they are defined, it's premature to speak of home computer "revolutions." At work, people may have to adapt to the idiosyncracies of computer systems with cranky software, but when it comes to the home, why should we?

Finally, I made a point I considered minor that seemed to catch everyone's eye. Noting that I haven't put the family budget on my home computer because it's easily managed with a hand calculator, I asked rhetorically: "Why glorify the trivial?" That phrase struck a responsive chord; even the Swedish television interviewer was at pains to include it in the tape.

Families That Compute Together Stay Together

Having read the column and the Toffler book, John T. Wilson of Somerville, Mass., wrote to take exception to my view. He notes that Mr. Toffler and others perceive a "schism between home life and business life in industrial civilizations" and an "exclusion of children and adolescents from business life [that has] alienated one generation from the next." He calls microcomputers "a viable alternative to the large-scale disruption of family life caused by centralized processing facilities."

The breakup of family life is blamed on many things these days—including television, women's liberation, and even the theory of evolution. But that's the first time I've heard of centralized processing as the culprit, nor did I realize I was its champion. Be that as it may, Mr. Wilson does highlight a possible benefit from home computers.

When they do make it possible to work from home, they can help integrate family life. Computer magazines and newspaper articles carry stories of how mothers are able to combine work and child raising. There is the occasional family that has gone into business en masse, with mom and dad selling computer software developed by a bright teenager. And severely handicapped people sometimes find the computer a means of doing profitable work, such as computer programming, from home. However, it is decidedly unclear when, if ever, the workplace will shift to the home on a socially significant scale.

A Reasonable Luxury

Thomas N. Hearn of Minneapolis, Minn., takes umbrage at my suggestion that using computers to do simple home-related tasks is overkill. "Why is it foolish to use a computer to do things we already do with less expense and effort?" he asks. I would have thought the reason is obvious. "Why is it foolish to challenge our minds rather than watch some silly program on that 'vast wasteland'?" he wonders. Read any good books lately? Mr. Hearn then proceeds to make my main point for me, saying his Apple provides him with cash-flow information, investment analysis, budgets, and other business tasks. He adds, "I don't known much about programming, but I'm learning, and . . . my children are learning too." He advises me "to remove [my] head from the sand and think about what is happening out there in the real world." (An excerpted version of these comments ran in the letters section of the February/March issue.)

It would seem that Mr. Hearn has a well-defined business need that a home computer can meet. He is also affluent enough to

provide several thousand dollars' worth of machine for his children's education. These are excellent justifications for a home computer. But out in the "real world," very few families are in such fortunate circumstances.

Creatively Applying the Tool

R. J. Mills of Schenectady, N.Y., notes that personal computers aren't living up to their prophets' vision because false expectations have been aroused. He notes that "proponents . . . misstate their case by presenting computers as the drivers of change rather than the tools of change." He adds, "Mr. Cowen . . . failed to catch this error on the part of those he criticizes."

How right he is. And how right he is also to point out that Gutenberg had similar problems when he invented the printing press, including a lack of creative ideas for applications. It took widespread literacy for the printing press to make its impact, to say nothing of the growth of a publishing industry. The home computer awaits a similar rise in computer literacy and an information industry that caters to it. These will be the real agents of change, for which the technology of home computing merely supplies the potential.

However, it still is hard to foresee exactly how this change will come about. Today's low-cost information services, such as CompuServ or The Source, are not well adapted to home needs. They offer a variety of services such as newspapers, which are read from a screen less conveniently than in their standard form and at much greater cost. Electronic shopping, where you can't see the goods, or electronic mail, with few people with whom you want to correspond connected to the system, aren't too useful either. Indeed, the main utility of the two services mentioned, outside of delighting computer buffs, is daytime service of business customers who have a genuine need for timely news, stock market quotes, or access to large computing facilities via the telephone.

But these services will evolve to become more widely useful. As Mr. Mills observes: "Computers are merely tools for creative people, not their driving force. There now are nearly 2 million personal computers installed, and the rate of growth is still accelerating. Give it time: like the monkeys with the typewriters, this degree of exposure of people to tools is bound to produce results."

This is undoubtedly a wise observation. But, oh, what a lot of garbage those monkeys banged out before they got around to Shakespeare.

Finally, there's a letter from Jeffrey L. Star of Santa Barbara, Calif., that cheers me on but says I missed a critical point. Mr. Star identifies himself as a "computer jockey" who uses five different systems at work plus one at home. Dear dear! I feel a bit overwhelmed with only three!

Mr. Star agrees that "there is no inherent reason for anyone to put up with an idiosyncratic, cranky system" either at a workplace or at home. "These problems are very real and crippling to many applications," he says. "The ultimate problem is not one of the machines we use, but rather one of human understanding and creativity to make these electric aids serve our lives."

Hear hear! □

Robert C. Cowen is science editor of the Christian Science Monitor *and former president of the National Association of Science Writers.*

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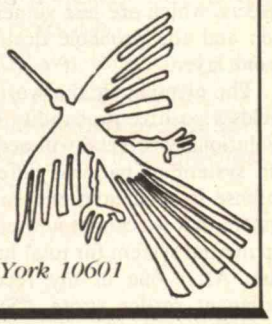
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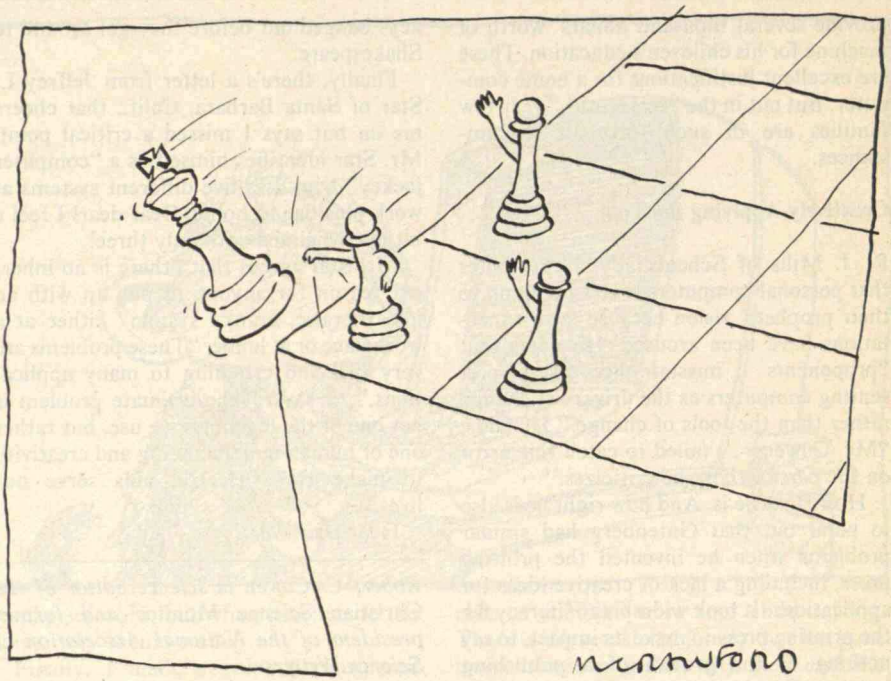


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Kenneth Boulding



Undoing Doomsday



I hate to return to a subject that is not only painful to write about but that, to judge from my correspondence, causes considerable pain to my readers, but truth and survival are more important than illusions and doom. The extraordinary articles by Jonathan Schell on nuclear arms entitled "Reflections" in *The New Yorker* magazine February 1, 8, and 15 are hard to read without some loss of sleep and some mental transformation. He argues that the rise in human knowledge to the point of releasing on the planet the energy that holds the atom in place has created a situation unprecedented in 4 billion years.

This knowledge has created a totally unfamiliar situation that we are reluctant to even think about. Knowledge, by and large, is about what is familiar. When we get into regions of extreme unfamiliarity, even in human situations such as the Great Depression and the accident at Three Mile Island, both knowledge and skill fail us. We do not know what buttons to press or what decisions to make. All we can hope to figure out is the rough probabilities that these events will occur, but this is very important knowledge. There is an enormous difference between an event with a probability of zero and an event with a probability of any finite number, no matter how small. An event with a probability of zero will never come off; an event with even the smallest finite probability will come off in a sufficiently long period of time.

It is now very clear that our present international system yields some positive probability that existing nuclear weapons will be exploded—they are all there waiting to go. If this happens, there is again a positive probability that the last billion years or so of evolution will be wiped out. Not only humans but mammals, reptiles, and trees will become extinct, and the earth will revert to an ecosystem of grass and insects, which are less vulnerable to radiation and the probable destruction of the ozone layer.

The element in the world system that yields a positive probability that this gross evolutionary reversal will occur is precisely the system of national defense. National defense is so ancient and so respectable a system that we cannot now conceive of it as a potential system for total human destruction. After one of my recent essays an indignant reader wrote, "Surely you believe in national defense?" The answer to that question is "No!" I believe that national defense is now inconsistent with any system of national security. It can no longer defend us; it can only destroy us—and the highest human priority should be to get rid of it.

It is one thing, of course, to say that this should be done, and quite another to know how to do it. This will require a major human intellectual effort. However, as the Chinese say, "The longest journey starts with the first step," and we better take it.

One Empire . . .

Some of the possible roads to the abolition of national defense are certainly closed. One road would be the development of a world empire or government. This road hypothetically might have been open to the United States in 1945 when we had a monopoly on the nuclear weapon. We might have said, I suppose, to all the countries of the world: "Join the United States as states or we will drop a bomb on you." Two nuclear bombs might have done the trick. However, this was clearly not a viable alternative: we were not ready for it, the world was not ready for it, and the human imagination could not grasp it. After the Russians started building their nuclear arsenal, that option was even further removed.

The world is too diverse for world government. Furthermore, its diversity is a good thing—the last thing we want is a uniform world culture. Variety is not only the spice of life, it is a great safeguard of the evolutionary process. Individuals and species perish, ecosystems survive—and evolution has persisted precisely because it produces this enormous variety. Whenever there is only one of any particular thing, then if anything goes wrong with it, everything goes wrong.

. . . Not Under Guard . . .

There is, however, a better solution than world empire. It is a world of separate nations living together in stable peace. This is no utopian dream. In the last 150 years we have seen a widening area of stable peace. There are now at least 18 nations, stretching from Australia and Japan across North America to Western Europe as far as Finland, who have no plans for going to war with one another. Their common frontiers are disarmed, and they have taken boundary change off their agendas. They may dislike and disagree with one another, but they will not break through that fragile line that divides peace from war. Stable peace is now the only workable form of national security, the only guarantee for human survival. In the last 150 years it has happened very largely by accident or luck. There is no reason why we cannot increase the probability of good luck through deliberate policy.

(Continued on page 84)

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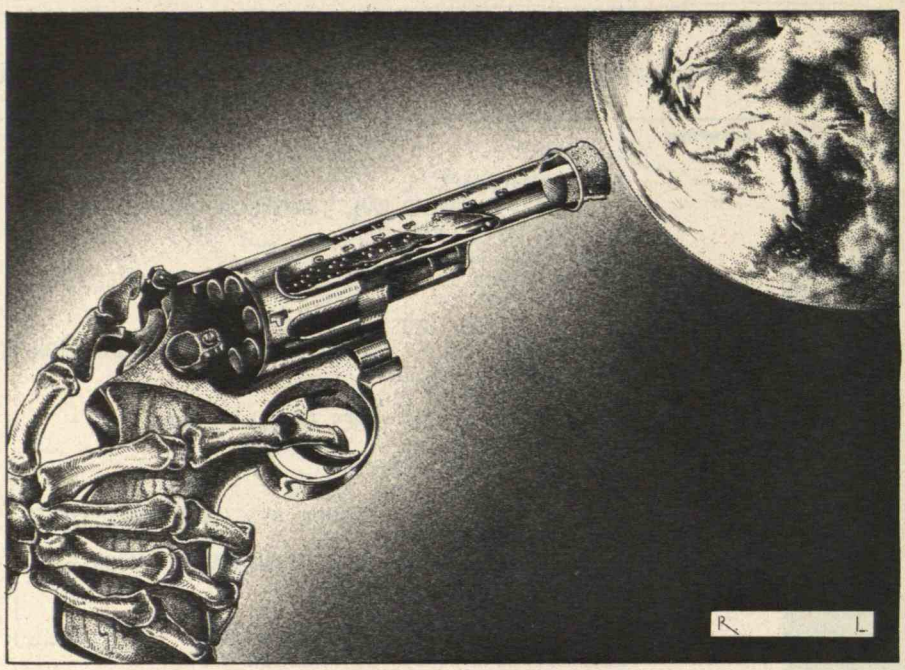
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The Threat of Biological Weapons

by Jonathan King

***Armis bella non venenis geri*—"War is waged with weapons, not with poison"**



ROGER LEYONMARK

REPUGNANCE toward chemical and biological warfare is ancient, as expressed by this Roman condemnation of the poisoning of wells. In the modern era, the Hague Conventions of 1899 and 1907 specifically forbid nations to "employ poison or poisoned arms" in war.

After the devastation wrought during World War I—when about 100,000 persons died from poison gas, according to the United Nations—stronger sanctions were sought. This led to the Geneva Protocol of 1925, which extended the prohibition covering poisonous substances to the "use of bacteriological methods of warfare."

The Geneva protocol was far from comprehensive regarding bacteriological weapons, however, since these had not been actively pursued by any of the great powers. And advances in microbiology and virology, combined with continued international hostility after World War II, stimulated development of large biological-warfare research facilities, such as those at Porton Down in Great Britain and Fort Detrick, Md. Still, biological weapons did not evoke broad enthusiasm among military thinkers because of the great uncertainty about their effects, the problem of ensuring that only the enemy would be victims, and their inefficiency on the battlefield.

With the advent of détente between the United States and Russia, the way was open for promulgating an even more explicit and stringent treaty. The result was the Bacteriological Weapons Convention of 1972, which prohibits the development, production, and stockpiling of such weapons. The convention states that the signatory nations are "determined, for the sake of all mankind, to exclude completely the possibility of bacteriological [biological] agents and toxins being used as weapons." The signatories agree never to produce biological agents with no peaceful purposes.

The Worry Goes On

However, serious grounds for concern over possible future use of biological weapons remain. Many nations have not signed the 1972 convention, and recent deterioration of East-West relations has increased the danger that governments may rationalize the need to develop such weapons. In fact, there have been charges that the international treaties are being violated.

For example, on March 18, 1980, the U.S. State Department declared that the anthrax outbreak in Sverdlovsk in the spring of 1979 was due to an accident at a Soviet biological warfare plant. The Cuban government has suggested that the recent outbreaks of disease in its tobacco and sugar crops may have been due to intentional introduction of biological agents by the CIA. And recently the Reagan administration has charged that mycotoxins are being manufactured in the Soviet Union and used as biological weapons in Cambodia.

Another factor prompting concern is that scientific knowledge about bacteria, fungi, and viruses has increased dramatically. In particular there has been a qualitative leap in our ability to modify these organisms by genetic engineering. As the creation of specially designed microorganisms for both research and commercial purposes moves forward, it is also increasingly possible to design microorganisms for military purposes. Thus, the conditions that fostered international restrictions on biological warfare—détente and limited military interest because of the technology's primitive nature—have changed.

Indeed, the U.S. Army proposed last year to the National Institutes of Health that government scientists investigate whether the gene for pneumococus toxin could be introduced into *E. coli*, a bacterium found in the human intestinal tract. And the army recently advertised in *Science* magazine for scientists interested in applying genetic engineering to the study of neurotransmittor sites, where many toxins and nerve gases act.

Germ Power

Because biological agents have not been used as major military weapons, discussions of their potential threat rest heavily on field and laboratory experiments and on studies of naturally occurring outbreaks and epidemics of infectious disease. However, consider that even with today's medical advances, infectious diseases still regularly cause major epidemics and many casualties worldwide.

Numerous natural viruses, bacteria, rickettsiae (a special group of microbes), and fungi could be enlisted as biological weapons. To kill or incapacitate humans, diseases such as Q-fever, cholera, yellow fever, epidemic typhus, eastern equine encephalitis, anthrax, and pneumonic plague could be intentionally introduced. An equally long list of disease agents can be used to attack agricultural plants and animals. For example, to destroy livestock, viruses are probably most effective. These agents could not only kill animals directly but perhaps would require compulsory

slaughter to prevent the spread of infection to other animals and even humans.

Because they are able to reproduce, biological agents are generally far more potent, weight-for-weight, than chemical agents. Chemicals are usually toxic at doses in the milligram range, while biological agents can act at doses down to trillionths of a gram. Biological agents can also spread over broader areas, multiplying as they pass from organism to organism. And if an agent establishes itself in some niche in the ecosystem, it may persist for a very long time.

Biological agents act much more slowly than chemical agents, so they are not effective battlefield weapons against enemy troops. Biological agents are more likely to be used against populations vital to a nation's social, agricultural, or industrial infrastructure—whether those be humans or agriculturally important plants and animals. The effects generally last for weeks or even months, rather than the hours or days associated with most chemical agents.

Two basic modes for delivering biological agents are militarily practical: by air as aerosols and by dispersion in water. For example, in a field trial described in a noted U.N. report, 200 kilograms of a harmless powder—in the form of tiny particles about the size of common bacteria—were released into the air from a ship located 16 kilometers offshore, while the ship traveled 260 kilometers along the coast. The resulting aerosol spray covered 75,000 square kilometers, 5,000 to 20,000 square kilometers of which would have received enough material to do serious harm. By comparison, the same amount of nerve gas would have been lethal over only 50 to 150 square kilometers.

No Way to Hide

Nations wanting to use biological agents as offensive weapons could provide protection—by vaccination or use of antibiotics—to their own troops or civilian populations. However, target populations would have little effective defense.

According to a United Nations report, "It is almost impossible to conceive of the complexity of the arrangements that would be necessary to control the consequences of a large-scale bacteriological attack. Even in peacetime, the development of an epidemic of a highly contagious disease introduced from abroad necessitates enormous material expenditure and the diversion of large numbers of medical personnel. . . . Large-scale bacteriological attacks could thus have a serious impact on the entire economy of the target country and, depending on the agent used, the disease might well spread to neighboring countries."

Whatever might be done to try to save human beings, nothing significant could be done to protect crops, livestock, or foodstuffs. And beyond the considerable damage to agriculture, there could be widespread ecological changes from deleterious changes in wild plants and animals.

Science Adds to Danger

As noted, there have been extraordinary advances in our understanding of the basic biology of bacteria, fungi, and viruses; of mechanisms of infection and pathogenesis; and of the development of genetic-manipulation techniques by recombinant DNA and other procedures. This increased knowledge and technology opens up several possibilities for developing new agents with increased survival under field conditions, transportability, virulence, and specificity for human, animal or plant populations.

For example, influenza outbreaks are triggered by natural variants of the basic flu virus with altered surface proteins. The altered surface makes a variant seem like a "new" virus to the body, and immunity developed against a previous viral strain has little or no effect. Scientists can now generate variants of influenza and other viruses in the laboratory by manipulating the genes controlling the outer protein coat. Vaccines available from previous outbreaks would not confer resistance against the new strains, but the nation producing these agents could of course produce vaccines against them.

Another possibility is to produce strains of bacteria resistant to common antibiotics by introducing the appropriate genes. Such strains might still be sensitive to a few little-used antibiotics, which the producing nation could store to confer protection when needed.

To attack an enemy's agriculture, biological agents would take advantage of the current pattern of crop monoculture. Since only a few strains of a given crop are planted across vast areas, infection with a virulent agent could cause great losses, as witnessed by the core borer attack on American cornfields in 1970. With the increased emphasis on the study of plants and plant pathogens, we will soon know how to genetically design selective agents for crop destruction. And, unfortunately, the destruction of crops has a long military tradition, the most recent example being the intensive use of herbicides and defoliants in Vietnam.

A problem in monitoring such developments is that research on defensive measures closely resembles research aimed at producing offensive agents. For example, the military might maintain that it is studying the effects of pneumococus toxin to prepare for use of such strains against U.S. forces—while the same kind of research could be used to develop the strain as a weapon.

Toward Greater Security

Despite recent statements by members of the Reagan administration, there is no convincing evidence that any nation has violated the 1972 Biological Weapons Convention. We in the U.S. must reaffirm our nation's commitment to this treaty and resist proposals to develop military capacity in this dangerous arena. We must also press for all nations to become treaty signatories. Claimed violations should be seriously and systematically investigated by the United Nations. However, nations making false claims of violations as a form of propaganda should be censured publicly. Such claims have historically been used to justify intensification of the arms race rather than control of it.

National scientific societies, such as the American Society of Microbiology, should stipulate that violation of treaty provisions also violates the society's rules and is grounds for expulsion. International scientific societies should incorporate similar charter provisions, providing a mechanism for isolating nations violating biological warfare restrictions.

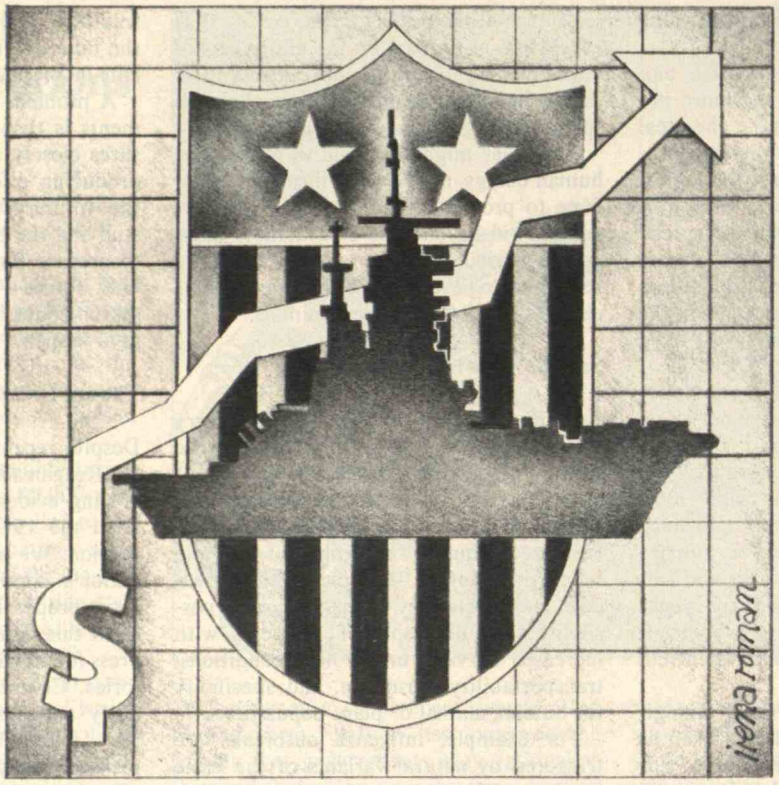
If we expect a treaty to have the force of law internationally, it should have the force of law nationally. Thus, individuals working on the development of biological weapons should be subject to appropriate legal punishment. This will require congressional action but is a relatively small step. The U.S. can and should be a leader in this area, as part of a change from cold war diplomacy to a diplomacy of peace and civilian technological development. □

Jonathan King is professor of molecular biology and director of the Biology Electron Microscope Facility at MIT. He is chairman of the Bacterial Virus Division of the American Society of Microbiology and was a member of the Committee on Biological Manipulation of the World Council of Churches.

The Moral Responsibility of Business

by Hyman G. Rickover

After more than 60 years in the military, Hyman G. Rickover left his post as director of the navy's nuclear propulsion program on January 31, 1982, at the request of President Reagan. As one of his last official acts, the four-star admiral addressed the congressional Joint Economic Committee on "how to promote greater efficiency and economy in the Defense Department." The following is excerpted from his testimony.



The Corporate Veil

IF our free-enterprise system is to survive, it is incumbent upon corporate executives to exercise greater self-restraint and accept moral responsibility for their actions, many of which appear to be having a negative influence on our economy and our society.

A preoccupation with the so-called bottom line of profit-and-loss statements, coupled with a lust for expansion, is creating an environment in which fewer businesspeople honor traditional values, where responsibility is increasingly disassociated from the exercise of power, where skill in financial manipulation is valued more than actual knowledge and experience in the business, and where attention and effort is directed mostly to short-term considerations, regardless of longer-range consequences.

Political and economic power is increasingly being concentrated among a few large corporations and their officers—power they can apply against society, government, and individuals. Through their control of vast resources, these large corporations have become, in effect, another branch of government. They often exercise the power of government, but without the checks and balances inherent in our democratic system.

With their ability to dispense money, officials of large corporations may often exercise greater power to influence society than elected or appointed government officials—but without assuming any of the responsibilities and without being subject to public scrutiny.

Many large corporations, because of their economic power and influence, have ready access to high-level government officials who, although not always familiar with the subtleties of the issues presented to them, all too often act without consulting their subordinates. This undermines the subordinates and does not always protect the interests of the taxpayer. Some large defense contractors know this and exploit it.

In the business world itself, many corporate executives, aided by shrewd lawyers, seek to evade moral and legal liability for the companies they own and control by insulating themselves from the details. Executives at corporate headquarters often can control their subsidiaries and draw out profits without assuming responsibility for contract obligations. This is the so-called corporate veil through which profits and cash can flow upward to corporate headquarters but that cuts off financial or legal liability.

Where responsibility is increasingly divorced from authority, traditional business values tend to be lost. Contracts often become meaningless. It used to be that a businessman's honor depended on his living up to his contract—a deal was a deal. Now, honoring contracts is becoming more a matter of convenience. Corporations are increasingly turning to high-priced law firms that, by legal maneuvering, obfuscation, and delay, can effectively void almost any contract—probably even the Ten Commandments. Under these circumstances, government contracts with some large companies are binding only to the extent the company wants to be bound.

Ever since the famous *Santa Clara County versus Southern Pacific Railroad* case in 1886, the Supreme Court has accorded corporations, which are considered "persons" in law, the rights of individuals under the 14th Amendment. I submit that if a corporation is to be accorded protection as a natural person, then all the obligations incumbent on "natural persons" ought also to be binding on corporations. And, since a corporation acts through its officials, they should be held personally liable for illegal corporate acts.

People, Not Reports

Certainly the profit motive is and should be the driving force in the capitalist system. However, in today's large corporations, managerial performance too often is measured solely in financial terms. In their world of financial statements, statistical reports, stock certificates, tender offers, and press releases, managers often lose sight of the people, materials, machines, and customers of the companies they control. Preoccupied with reports and numbers rather than people and things, these executives tend to oversimplify operating problems and their solutions.

Furthermore, by focusing too strongly on "bottom-line" results, corporate officials can generate pressures that cause subordinates to act in ways they would not consider proper in their personal affairs. Under pressure to meet assigned corporate profit objectives, subordinates sometimes overstep the bounds of propriety—even the law. But the corporate officials who generate these pressures are hidden behind the

remote corporate screen and are rarely, if ever, held accountable for the results.

In recent years several major shipbuilders, when faced with large projected cost overruns, resorted to making large claims against the navy. Ignoring their own responsibility for poor contract performance, the contractors generated claims that attributed all the problems to government actions and demanded hundreds of millions of dollars in extra payments—enough to recover all their cost overruns and yield the desired profit. Sometimes the claims were many times the desired objective so that the company could appear to be accommodating the navy by settling for a fraction of the claimed amount.

In evaluating these claims I found numerous instances of apparent fraud. I documented these instances in great detail and, in accordance with navy directives, sent these reports to my superiors, recommending that they be referred to the Justice Department.

In the 1970s the navy referred the cases of four large shipbuilders to the Justice Department for investigation. However, the Justice Department seems incapable of dealing with sophisticated procurement fraud—or perhaps is undesirous of doing so. After nearly a decade of work, the status of these cases is as follows:

☐ Litton was indicted four years ago for fraud, but the Justice Department has taken no action to try the case.

☐ The Justice Department conducted a lengthy investigation of Lockheed claims but did not issue an indictment. By now, the statute of limitations has expired.

☐ After investigating General Dynamics for four years, the Department of Justice recently announced it could find no evidence of criminal intent, although the claims were almost five times what the navy actually owed.

☐ The investigation of Newport News was recently dealt a serious blow when the Justice Department split up the investigating team and assigned the leading investigators other work. This happened shortly after they had reported their findings and had asked the department for more help to track down other promising leads.

I believe the grossly inflated claims to which the navy was subjected during the past decade are an outgrowth of the philosophy in some companies that "anything goes" in meeting the profit objectives set by senior corporate officials.

While profit figures may be a convenient basis to assess managerial performance, they can be manipulated, particularly by

Better Defense at Lower Cost



Senior civilian officials appointed to positions in the Department of Defense traditionally express their commitment to reduce waste and promote efficiency. They issue directives urging subordinates to save money, protect the government's interests, comply with all applicable laws and regulations, report fraud, and so on.

However, these policy directives generally turn out to be primarily public-relations documents. While creating an appearance of action and progress, they frequently obfuscate more fundamental problems. Eventually they are quietly abandoned—and with no action taken.

Instead we need to create, by actions rather than words, an environment in which those in the Defense Department can operate efficiently and obtain from industry needed goods and services at minimum cost to the taxpayer.

I have therefore [prepared] recommendations for specific improvements in the organization of the Defense Department, in military personnel policies, and in procurement. I gave these recommendations to the director of the Office of Management and Budget in the spring of 1981, but have seen no evidence of action within the executive branch to implement any of them. It will have to be Congress that takes the initiatives.

Simplify Defense Department

There is a need to streamline the Department of Defense. Eliminate unnecessary organizational layering—it is detrimental to performance and results in much delay and diluted responsibility. In many cases, the "checkers" outnumber the "doers."

Those at the top of the department are too far removed from the subordinates who are knowledgeable and must do the work. As a result, the top people tend to seek advice from their personal staffs, consultants, and contractors rather than from the department's own professionals. In fact, several previous navy secretaries discouraged recommendations from their subordinates while maintaining an open door to some large defense contractors.

Reduce the large numbers of people staffing the offices at each layer. When the Office of the Secretary of Defense was established in 1946, the Secretary of Defense was to have three special assistants and a small executive office. Today there are over 1,000 on the secretary's staff. This vast staff slows down decision making, diminishes the job of the service secretaries, and allows non-knowledgeable and nonresponsible officials to make decisions.

Stop the undue reliance in the military on management information systems and systems analysis. The preoccupation with "management" in the Defense Department is stifling. At each level of the bureaucracy, people try to impress higher authorities by accumulating masses of unnecessary information before making a recommendation.

Reduce the number of flag officers (admirals) in the Defense Department—savings will come from eliminating the staffs that cling around each of them. Some flag-officer positions exist only to take care of officers whose turn it is to have shore duty.

The wasteful practice of transferring military people from one location to another every two or three years should be stopped. In addition to costing a lot, frequent personnel transfers are disruptive and cause inefficiency. But, the major savings will come from leaving people on the job long enough to learn it and to be held accountable for results.

Pay military personnel a regular salary rather than today's confusing system of pay, allowances, and fringe benefits. A salary system would be far simpler and more equitable than the present system. Military personnel, as well as the public, would then have a better appreciation of how much they are actually being paid. Special pay in addition to salaries should be granted only as

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large corporations with various businesses. Through "creative" accounting, a large company can tailor its financial statements to convey to stockholders, and others, a picture quite different from that warranted by the company's performance. Some large corporations have been able to generate optimistic financial reports even when they were near the point of bankruptcy. By assuming that they would be awarded large claim payments from the government, some shipbuilders, year after year, were able to report to the public increasing profits—even record profits—while they were reporting to senior defense officials hundreds of millions of dollars in potential losses.

The reason I mention these problems is to question an increasingly popular notion; namely, that the so-called forces of the marketplace are enough to motivate large corporations to act responsibly and exercise self-restraint. Businesspeople regularly complain that overregulation by government inhibits their freedom and accomplishments, yet it is the very acts of some of them that have made regulation necessary. Adolf Berle perceptively observed that when business threatens to engulf the state, it forces the state to engulf business.

The notion that we have a self-regulating, free-market economy that prompts a high standard of ethical business conduct is not realistic in today's complex society. I believe that businesspeople must treat government regulation realistically rather than with instinctive opposition. Much of government regulation is essential to protect the public against a recurrence of past abuses, and because it is unrealistic to expect any group to truly police itself. Businesspeople must face the fact that regulation is inevitable. Blind opposition to all regulation detracts from the valid complaints business may have about the excesses of regulation.

Business Wants the Cake

Often the largest businesses—those least subject to the restraints of free enterprise—are the most outspoken advocates of the free-enterprise system as an effective safeguard against these excesses. They want the public to believe that they behave in accordance with the free-enterprise system when in fact they escape many restraints of that system. They consistently lobby against new government regulations, heralding the virtues of competition and the marketplace as if they were small-businessowners subject to these forces. Yet they also lobby *for* government—that is, taxpayer assistance in the form of tax loopholes, protected markets, subsidies, guaranteed loans, contract bailouts, and so on.

Businesspeople should vigorously advocate respect for law because law is the foundation of our entire society, including business. Few areas of society are as dependent on law as business. The law protects such essential rights of business as integrity of contracts. When businesspeople break the law, ignore or destroy its spirit, or use its absence to justify unethical conduct, they undermine business itself as well as their own welfare.

They should be concerned with the poor record of law enforcement as it relates to them. They should be concerned about the double standard where an ordinary citizen is punished more severely for a petty crime than corporate officials convicted of white-collar crimes involving millions of dollars.

Theodore Roosevelt was the nation's foremost proponent of rugged individualism and a strong advocate of business. But he witnessed the growing cynicism among ordinary citizens toward a government that permitted one law to govern powerful corporations and another to govern individual citizens. He recognized that corporate lawlessness was undermining the very foundation of democracy. It was in this sense that he engaged in his famous battles with the "malefactors of great wealth."

Although I have been critical of some current trends in business, I am not hostile to business. Despite its present moral obtuseness, I believe in free enterprise and the capitalist system. No other system offers as much opportunity for individual freedom and accomplishment.

The "founding fathers" of the nation valued freedom and culture more than wealth. They brought fundamental honesty to the business of government and dealt with their countrymen in frank and open terms. The Declaration of Independence was no idle statement for them. In support of it they pledged, and some lost, their lives and fortunes. Through their beliefs and individual deeds, our revolutionary leaders stirred their fellow countrymen to struggle and sacrifice for independence. More important, they set a moral tone and example for their age and ours. We should try as best we can to emulate them. □

Admiral Hyman G. Rickover began his career in 1918 when he entered the U.S. Naval Academy. He served under 13 presidents and is widely regarded as the father of the nuclear navy.

(Continued from page 13)
necessary to attract people with essential skills in short supply.

Phase out the practice of military personnel receiving retirement pay after 20 years of service. Encourage military people to pursue careers of 30 years unless disabled or not able to meet the needs of the service.

Increase the navy's return on investment from the training of midshipmen at the Naval Academy and in the Naval Reserve Officer Training Corps (NROTC) Program. The curricula at both the Naval Academy and NROTC colleges and universities should assure that midshipmen develop a proper technical background to enable them to meet the needs of the navy rather than simply pursuing their own personal whims. Midshipmen who resign after their first two years should be required to serve as enlisted people or pay back the cost of their education.

Cut back the officer postgraduate education program. Few jobs in the navy require a graduate degree, particularly in the nontechnical areas where many naval officers conduct their studies. Postgraduate education has become, in many cases, a fringe benefit where officers can, at government expense, improve their creditials for jobs after they leave the military.

Seeking Better Buys

The Department of Defense needs to become a more demanding customer with regard to quality, performance, and price. Defense contractors pursuing their own financial interests do not automatically provide quality goods and services at the lowest possible cost.

The Defense Department's Independent Research and Development (IR&D) program should be abolished or drastically cut back. The Department of Defense spends $1.5 to $2 billion a year subsidizing IR&D projects, in addition to the research and development contracts it awards directly. Contractors initiate these projects, yet the Defense Department has no say over the work to be done and has no right to the ideas developed—even when the government pays nearly the total cost.

The Defense Department should not tolerate contractors who, through their own inefficiency, incur cost overruns, fail to meet delivery schedules or quality requirements, and try to shift these problems to the government through inflated claims and threatened work stoppages. During the past decade these problems plagued navy shipbuilding and they will inevitably recur.

Defense officials encourage poor performance, buy-ins [underbidding to obtain a contract], and claims when they settle claims for more than the government legitimately owes. In this regard, Navy Secretary Lehman deserves higher marks than his predecessors for insisting that General Dynamics not be awarded more Trident-class or Los Angeles-class submarine construction contracts until that company abandoned its "insurance claims" to recover the cost of correcting defective workmanship.

To obtain the advantages of competitive bidding, the Defense Department must enforce its contracts. The navy has awarded contracts to build 32 ships of the SSN 688 class through competitive bidding. Electric Boat, the less efficient yard, has won contracts for 20 ships; Newport News has won only 12. Because the navy has been unable to enforce the contracts, it has ended up paying Electric Boat more for these ships than it has paid for comparable ships bought from Newport News, and the Newport News ships have been delivered far earlier.

Congress should pass legislation providing explicit authority for the Department of Defense to award contracts to other than the lowest bidder in cases of an apparent buy-in attempt, or when the secretary determines that an award to other than the lowest bidder would likely result in savings to the government. For several years, the navy was convinced that Electric Boat was bidding unrealistically low to take SSN 668 business away from Newport News. Navy lawyers took the position that the navy was obliged to award to the low bidder anyway, because Electric Boat could do the work.

Less Carrot, More Stick

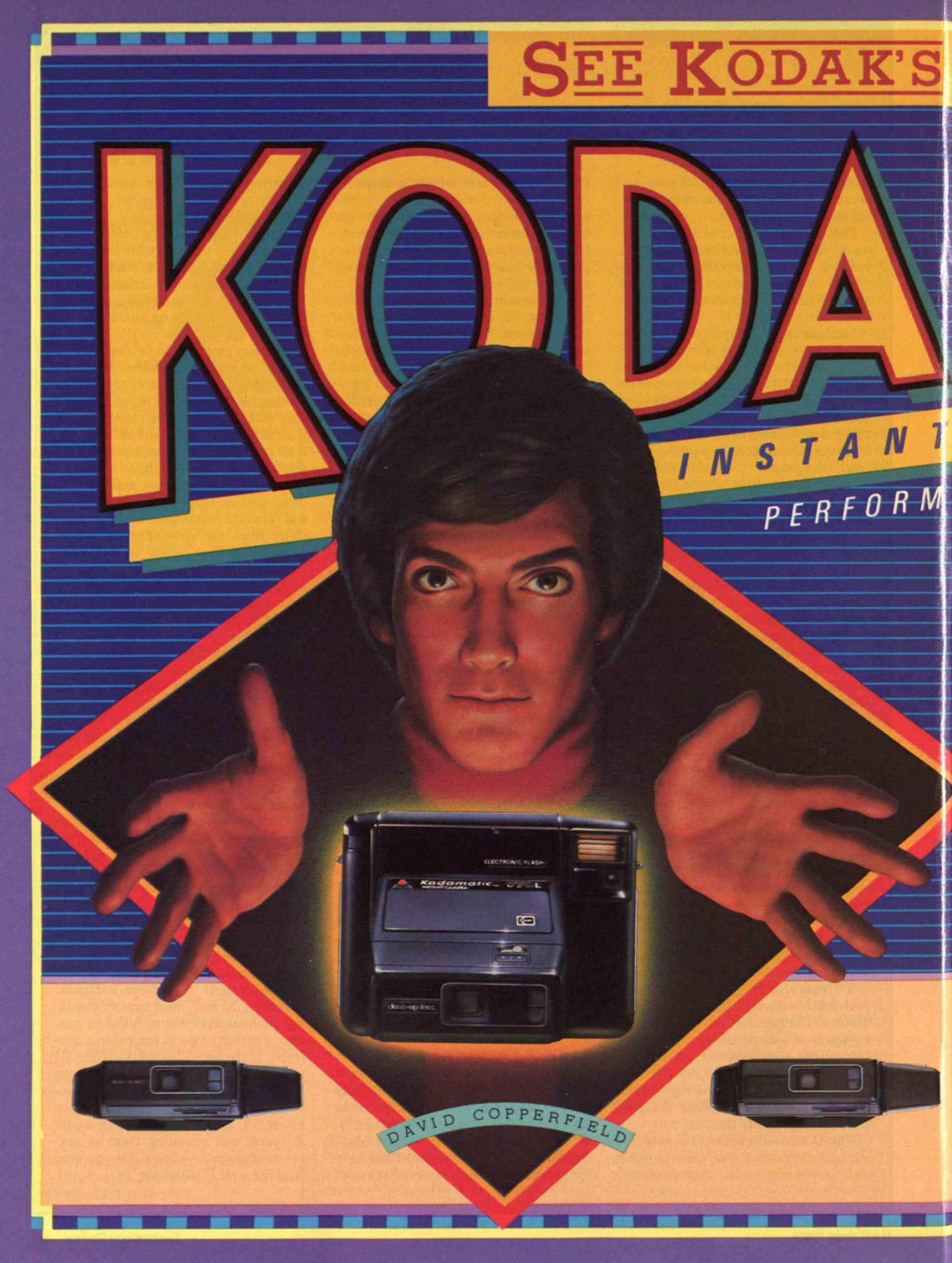
Senior defense officials should not rely heavily on special financial incentives to entice contractors into performing efficiently. Past experience in the shipbuilding industry shows that these have not worked and that the navy has ended up paying more without actually improving performance. Instead of spurring improved performance, financial incentives have merely prompted contractors to try to qualify for the bonus by negotiating for higher target costs and extended delivery schedules.

Congress should establish a one-year statute of limitations on submission of contract claims. This would provide contractors ample time to identify and submit all legitimate claims, but foreclose the present practice of contractors waiting for several years to see how well they make out on a given contract and then submitting claims to make up for their overruns. Contractors, particularly shipbuilders, presently have an incentive to delay submitting claims. The delay enables them to obfuscate issues and frustrate government analysis of the claim since the knowledgeable people have frequently moved on to other jobs.

To deter those who would stop work on certain defense contracts, the Defense Department should be required to stop further payments on all contracts with any corporation while any segment of that corporation does not proceed in good faith. Congress should also enact legislation to require that contractors who stop work as a result of a contract dispute will, for any new contracts awarded in the succeeding ten years, be required to obtain a performance bond, the cost of which may not be passed on to the government.

Congress should require the navy to reinstate nuclear submarine construction in naval shipyards. This would provide needed construction capacity, maintain the navy's own construction capability, and provide alternatives in cases were private yards decide to deal improperly with the government.

I hope the government will adopt my recommendations and acquire an ability and willingness to enforce contracts. However, the navy must have shipbuilding facilities available to fulfill its mission, whether or not it can enforce contracts. If the navy is unwilling or unable to enforce its contracts, and must pay a shipbuilder's costs regardless of fixed-price contracts, I believe it would be better off acquiring or leasing major shipyards and operating them as government-owned, contractor-operated facilities.—*H.G. Rickover* □


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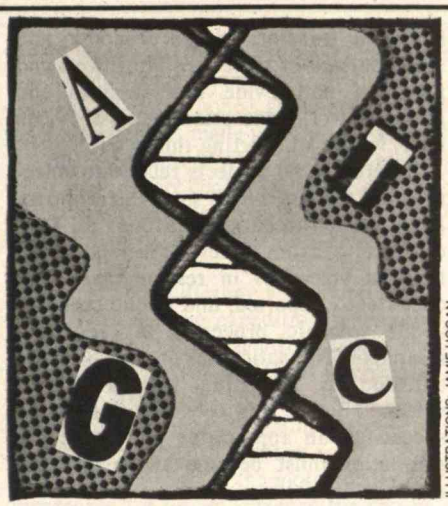
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The Ultimate Puzzle

Discovery: The Search for DNA's Secrets
by Mahlon Hoagland
Boston: Houghton Mifflin, 1981, 198 pp.

Reviewed by Janis Koehler Fraser



ILLUSTRATIONS: JAMIE HOGAN

Those who see in the title *Discovery: The Search for DNA's Secrets* a layperson's guide to today's newsy recombinant DNA research will be disappointed. The book devotes barely a paragraph to the subject. It is instead a layperson's guide to molecular biology—the struggle to solve the mystery of the gene. It begins with Gregor Mendel's pea plants and breaks off rather awkwardly with the cracking of the genetic code in the 1960s.

The book's author, Mahlon Hoagland, is now head of the Worcester Foundation for Experimental Biology in Shrewsbury, Mass., an institution best known for its development of the birth-control pill. He brings to his subject more than his expertise as a molecular biologist, for he was privileged to have been a bit player in the drama of which he writes. In the 1950s, he was part of the laboratory team at the Massachusetts General Hospital that discovered transfer RNA, nucleic acids with an important function in protein synthesis.

Hoagland's purpose is threefold. First, he describes in nontechnical language the fundamentals of molecular biology: the nature of DNA—the genetic material—and how information encoded in DNA is controlled and processed in the process of building proteins. This Hoagland does admirably while conveying his own esthetic delight in the symmetry and elegance of these fundamentals. Such simplification does strip the subject of some of its splendid intricacies, but Hoagland wisely chooses to sacrifice detail in favor of keeping his nonscientist readers on track. A thorough grasp of the essentials is necessary to make sense of the history of their discovery, which is the author's second purpose.

Quite apart from its scientific significance, the history of the unraveling of heredity's secrets is a good read. It has been told before but rarely in a form appropriate for general readership. Hoagland provides a spare description of the significant discoveries with a feel for how each relates to those that came before and after.

For example, the watershed elucidation of the structure of DNA by Watson and Crick was not a bolt entirely out of the blue. It was based upon experimental evidence painstakingly gathered for years by both x-ray crystallographers (those who deduce the molecular structure of crystals from their x-ray diffraction patterns) and biochemists, who were inspired by the earlier discovery that the genetic material consisted of DNA. Publication of the double helical model of DNA by Watson and Crick then stimulated a progression of discoveries that led to the cracking of the genetic code and the details of how information is transferred from DNA to protein.

This historical perspective is Hoagland's major strength and provides the means for him to fulfill the third and, according to him, most important purpose of the book: to explain to nonscientists the scientific process, "the *how* of science."

The general public receives most of its "science news" through media that rarely explain the method behind scientific progress. How do scientists get to where they want to go? As Hoagland says: "In science, ideas are a dime a dozen. The really important ideas, which are rare, are the ones that can be tested, that point clearly to an experiment that will give an unequivocal answer to a well-formulated question."

In 1943, Salvador Luria had just such an idea for an experiment. His experiment elegantly proved that bacteria obey the same evolutionary rules as higher organisms—mutation and selection—and removed a serious obstacle to the study of bacterial genetics as a model for all genetics.

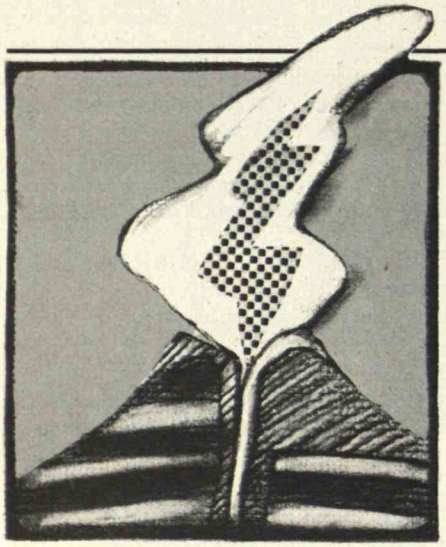
Generally, however, scientists inch along, says Hoagland, "exploring whether they are right." Such was the experience of Mendel in his patient work with pea-plant genetics that predated molecular genetics by some 70 years. When Hoagland adds that an "unexpected event often leads to a profound new insight," he undoubtedly has in mind his and Paul Zamecnik's own accidental discovery. They observed the unexpected incorporation of amino acids into RNA as an adjunct to another experiment, a finding that led to their discovery of transfer RNA.

Hoagland then describes the final "clinching effectiveness" of science: the universal verifiability of scientific truths. Elsewhere in the text he points out that Griffith's critical 1928 experiment, which provided a handle on the physical nature of genes, was greeted with uniform skepticism by the scientific establishment. Had no one been able to repeat Griffith's incredible experiment revealing the transfer of a heritable trait between bacteria, it would have been tossed onto the ashheap of meaningless and misbegotten results. But researchers in several laboratories around the world did successfully repeat the experiment, forcing acceptance by their most reluctant colleagues. Refinements led to Oswald Avery's demonstration in 1944 that DNA is the stuff of which genes are made, thus laying the cornerstone of molecular biology.

Hoagland does a generally excellent job of describing both the biological facts and the process of uncovering them. Exceptions include his fuzzy explanations of sexual conjugation (the injection of genetic information by one bacterium into another, a phenomenon crucial to the development of molecular genetics); the complementation test, an important method that allows geneticists to map the relative positions of mutations along the bacterial chromosome; and how the last great riddle of this early era of molecular biology, the genetic code, was solved. Another drawback is his drawings, which, while ample, are of only mediocre quality.

While nuclear physicists, astronomers, paleoanthropologists, and others may quarrel with Hoagland's assertion that "the discovery of the gene and how it works [is] science's most incredible story," few will disagree that it ranks near the top for dramatic interest, intellectual satisfaction, and significance to humanity. *Discovery: the Search for DNA's Secrets* successfully conveys all three to readers curious about the "new biology" but unprepared for more technical treatments of this fascinating subject. □

Janis Koehler Fraser is a free-lance science and medical writer with a Ph.D. in biochemistry and molecular biology from M.I.T.



Fire and Brimstone

Volcanoes
Robert Decker and Barbara Decker
San Francisco: W.H. Freeman and Co., 1981, 244 pp., $18 hardcover, $9 paper

Reviewed by Donald W. Peterson

Until recently, most Americans were either complacent about or oblivious to volcanoes. Many perceived them simply as pointy-topped mountains with emissions that sporadically wreaked havoc in distant places. Lava flows from Etna that threatened Sicilian villages, persistent ash emissions that disrupted the agrarian economy of a small Central American nation, and a new volcanic island emerging from the sea near Iceland evoked only passing interest. Most Americans had also heard of the volcanoes of history books: Vesuvius and its destruction of Pompeii in 79 A.D., Krakatoa and its immense eruption in 1883, and Pelee and its annihilation of St. Pierre on Martinique in 1902, each of which caused tens of thousands of casualties.

Even American volcanoes were mainly conveniently confined to the two most remote states, Hawaii and Alaska. When geologists pointed out that the Cascade Range of the Pacific Northwest consists of a chain of potentially active volcanoes, they aroused little interest; the threat was too vague to be realistic to the average citizen.

But these perceptions changed abruptly in 1980. After modest preliminary activity lasting a few weeks, Mount St. Helens erupted cataclysmically on May 18, and a new realization of the impact of volcanoes was thrust upon Americans. The resulting fatalities, property damage, and devastated landscape transformed the economic and social outlook of the entire Northwest and produced nationwide repercussions and garnered worldwide attention. Two years later, we are still sorting things out.

Interest in all subjects related to volcanoes has remained high since the eruption. Even minor rumblings of Mount St. Helens receive national news coverage, eruptions of volcanoes in remote places are consistently reported, and public curiosity about volcanic processes is seemingly insatiable. The nation has at least partially adjusted to coexisting with an active volcano. But if this coexistence is to be successful, an appreciable portion of the population must become aware of some rudimentary facts.

Volcanoes, written by Robert and Barbara Decker, suits the bill nicely. Although conceived and largely written before Mount St. Helens revived, the timing of its publication in early 1981 was serendipitous. The book is written for literate persons of almost any background. Simple and clear, it is not encumbered with the specialist's jargon, and essential scientific terms are defined in an effective glossary.

The Deckers introduce their subject through an excellent summary of the concept of plate tectonics, the theory that the outer layer of the earth consists of roughly ten major "plates" that move relative to one another. This hypothesis has revolutionized the way geoscientists view the earth.

Succeeding chapters demonstrate how each major volcanic type fits into the plate-tectonics scheme. The authors describe the eruptions of selected volcanoes in sufficient detail to demonstrate the various characteristics and results of plate movements. They build on this framework to describe the products emitted by volcanoes, the characteristics and morphology of volcanic landforms, and current ideas about the deep-source regions beneath volcanoes. They then devote a series of chapters to the consequences of volcanoes: their central role in the evolution of the seas and the atmosphere, for instance, and the delicate balance between volcanism and a host of other natural processes. The Deckers also review volcano-related subjects with direct economic concern to society, including power from volcanic sources, mineral resources, and the influence of volcanoes on climate.

In the final chapter, the authors discuss the challenge of attempting to forecast eruptions. Mount St. Helens in 1980 is one example of a partially successful forecasting attempt.

Volcanoes is well conceived and organized, its illustrations are informative and attractive, and the facts and concepts it presents are authoritative. However, the authors do neglect to discuss the social and economic problems caused by major eruptions, problems that go far beyond direct casualties and immediate destruction. These eruptions affect such things as property values, investment patterns, tourism, and industrial and commercial development, as well as the emotional and psychological health of human beings. Long-range planning based on a thorough understanding of volcanic processes could greatly reduce these adverse consequences. □

Donald Peterson is scientist-in-charge at the U.S. Geological Survey's Mount St. Helens Project in Vancouver, Wash.

Southern Exposure

Scott and Amundsen: The Race to the South Pole
Roland Huntford
New York: G.P. Putnam's Sons, 1980, 665 pp., $19.95

Reviewed by W.F. Weeks

On June 1, 1910, Robert Falcon Scott left London in the ship *Terra Nova* in command of an expedition bound for the Antarctic with the avowed purpose of reaching the South Pole. Six days later, Roald Amundsen sailed from Christinia, Norway, on the *Fram*, ostensibly on his way to the North Pole. Actually, since Peary had announced the conquest of that prize 14 months earlier, Amundsen was also heading south in search of the goal that beckoned Scott: the last glittering jewel of geographic exploration.

It is generally believed that Amundsen beat Scott to the Pole by lucking into an easy route and good weather. Scott, who arrived at the Pole a month later after overcoming countless difficulties, perished along with his entire five-man party on the return trip. When he died he was 11 miles from a supply depot. Hence the inevitable question: was the difference between success and failure just a matter of chance?

Huntford has put together a monumental treatise that not only answers this question but probes into the minds and motivations of these legendary adventurers. The fascinating story includes a pertinent history of polar exploration, background on the



protagonists, their motives (an almost religious pure Pole-seeking sense for Amundsen, advancement in the Royal Navy for Scott), their apprenticeships (the first transit of the Northwest Passage in the *Gjoa* for Amundsen, the *Discovery* expedition to the Antarctic for Scott), the incredible politics of organizing the expeditions, and finally the climactic "duel" for the Pole.

Although, there are a number of other books on this subject, I know of no other that provides such insight into the nature of the two Polar thrusts and why one group succeeded while the other perished. The contrasts between Amundsen and Scott were extreme. Amundsen was the personification of the *Norsk* raider who steals into the night with a small party and gains the prize. Every aspect of his operation was researched, tested, modified, and retested. His men were not only specialists but were all thoroughly accustomed to polar operations and oversnow travel. He knew how to use skis and dogs to their full advantage. He believed that the native peoples of the polar regions such as the Inuit and Lapps had much to teach modern people, so he learned their ways and built on their techniques. He also was a diligent student of those earlier explorers whose methods he admired—men such as Rae, Collinson, Nansen, Sverdrup, and Peary who, with small parties, training, and skill, had succeeded where larger groups had failed. Every spare moment was spent polishing skills and improving equipment so that the goal could be reached with minimum effort and maximum safety.

Amundsen's journey was not easier than Scott's; if anything, it was more difficult, in that he used a totally unexplored route while Scott followed in the footsteps of Shackleton, a man he disliked and sought to discredit, and whose success haunted him. Amundsen's journey appeared easier because his finely honed skills and knack for understatment made it seem so. Attaining the South Pole by the route Amundsen chose was a severe challenge, but he and his men were up to it. It was a thoroughly professional operation under the hand of a master.

Things were different with Scott, who commanded a large expedition that operated under the militarized discipline of the Victorian navy. Although Scott had led the *Discovery* expedition, he seemed to have learned little from it. When he set sail for McMurdo Sound in 1910 he was, except for the development of the motor sledge, as unprepared for icecap travel as the day he retreated from the cap at the end of 1903. He distrusted skis and dogs, both proven methods of travel, and neither he nor his men were properly trained in their use. Learning from primitive cultures was alien to Scott, who believed that civilized people invariably knew best. Although he was eager to experiment with new techniques for ice-sheet travel (motor sledges and ponies), he neglected either to adequately test them or provide alternatives in case of their failure—and both sledges and ponies failed.

Scott made little attempt to understand the world he chose to invade. He had a lordly disregard for his technical insufficiencies and relied chiefly on his nerve to get him through. Worst of all, he felt that doing things the hard way was a virtue. Nowhere is this more clearly revealed than in his statements about man-hauling of sleds, a grueling task that in a trip of the magnitude of Scott's was certain to result in the physical deterioration of the haulers. "No journey ever made with dogs can approach the height of that fine conception which is realized when a party with their unaided efforts go forth to face hardships." Anyone who has spent a day walking on an icecap, even without dragging a heavily loaded sled, knows that statements like this make better press than sense. If such thinking guides the organization of an expedition, it can kill, as Scott's case testifies.

As a leader, Scott comes across as a rather insecure, unhappy, and emotional disciplinarian with a self-destructive inability to admit mistakes. Where Amundsen had a gift for making the right decision, Scott had a knack for making the wrong one. Three prime examples are Scott's spur-of-the-moment change of the size of the Pole party from 4 to 5 men, thereby lessening the survival chances of both those going to the Pole and those returning to McMurdo Sound; the several confusing sets of orders, all oral, specifying where and how the Pole party was to be met; and the decision not to move the "One Ton" supply depot 30 miles further south as initially planned and urged by his men (Scott perished 11 miles south of the depot). Scott's party was composed of capable and valiant men; if they had had better training and leadership, they could have returned safely from the Pole, though it is doubtful they could have beaten Amundsen to the prize.

Scott's real strength lay in his prowess as an author and his ability to get the British populace emotionally involved in his quest. Through the written word, Scott reached from the grave to steal recognition from Amundsen. While Scott became legendary for dying a hero's death in the face of supposedly insurmountable difficulties, many of these difficulties were of his own construction.

Huntford is relentless in documenting Scott's failures, and "Scottphiles" may feel their hero has been unjustly attacked. But whatever one's final judgment of its balance and fairness, *Scott and Amundsen* will certainly provide the casual reader with an intimate glimpse of a fascinating and heroic piece of history. Even the experienced reader of other books on polar expeditions should gain many additional insights into this epic struggle. □

Willy Weeks is a glaciologist at the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, N.H., who specializes in studies of snow and ice in polar regions.

Upcoming in our July issue:

The Emerging Threat of Groundwater Pollution:

Documenting the contamination of a source once considered safe and indicating that the full impact of the problem has yet to be felt.

Plant, Feed Thyself:

How recombinant DNA techniques may make possible the "engineering" of plants that produce their own nutrients from essentially unlimited inputs: nitrogen from the air and energy from the sun.

Winning Through Sophistication:

The former undersecretary of defense for research and engineering details an "offset strategy" to counter the Soviet weapons advantage by exploiting the American technological edge.



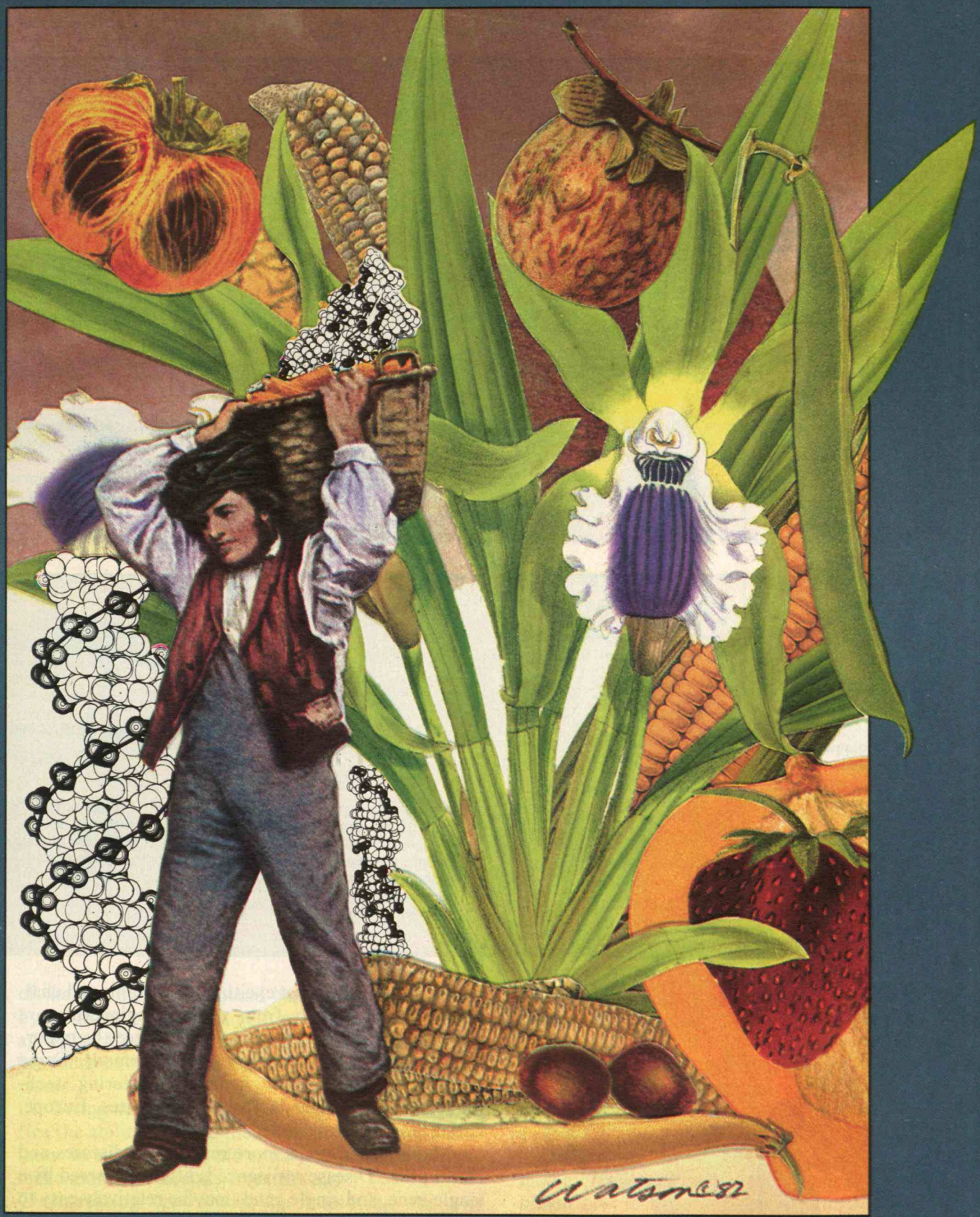
Engineering a New Agriculture

by Robert Cooke

Biotechnologies have already led to a minor revolution in plant production by giving us the means to tailor crops to meet specific human needs.

GENETIC engineering has helped erode barriers that once prohibited crosses between different species. Within the past decade, scientists have found ways to "tailor" microbes to do specific tasks by furnishing them with genes selectively plucked from other organisms.

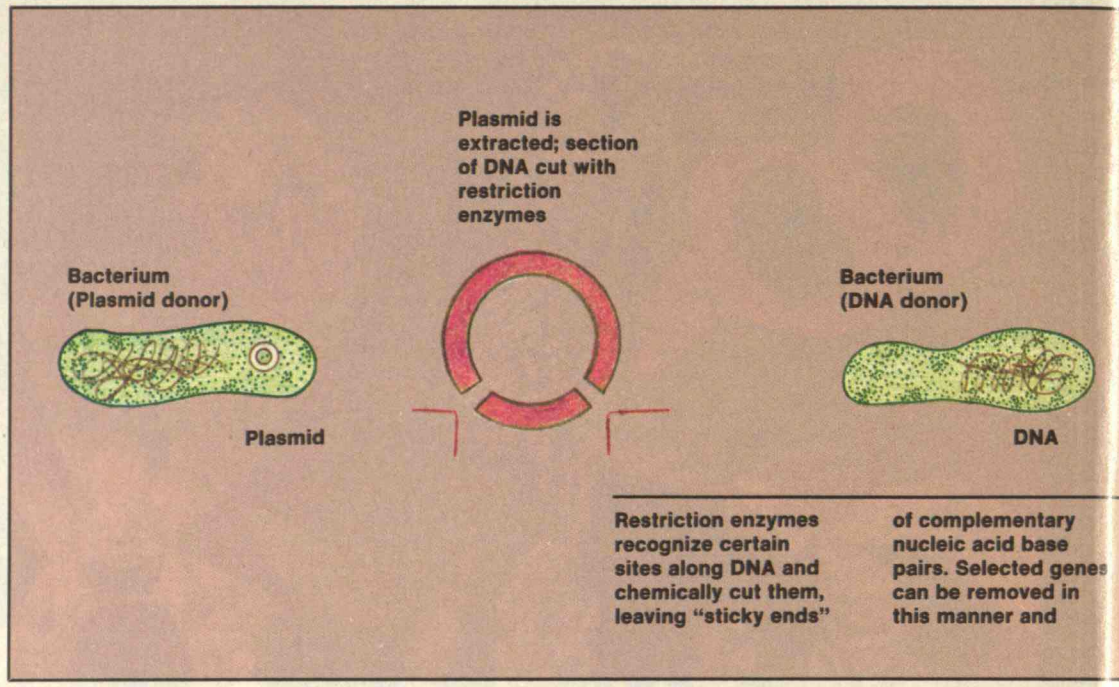
Bacteria and yeast can be made to produce medically useful products such as human insulin, growth hormones, interferon, and hepatitis B vaccine. They can also be designed to participate in industrial processes, providing cheaper and less pollution-prone ways to make alcohols, sugars, proteins, enzymes, and other products. Bacteria are even being manipulated to improve the leaching of metals from ores, to clean up oil spills, and to detoxify pollutants.



KAREN WATSON

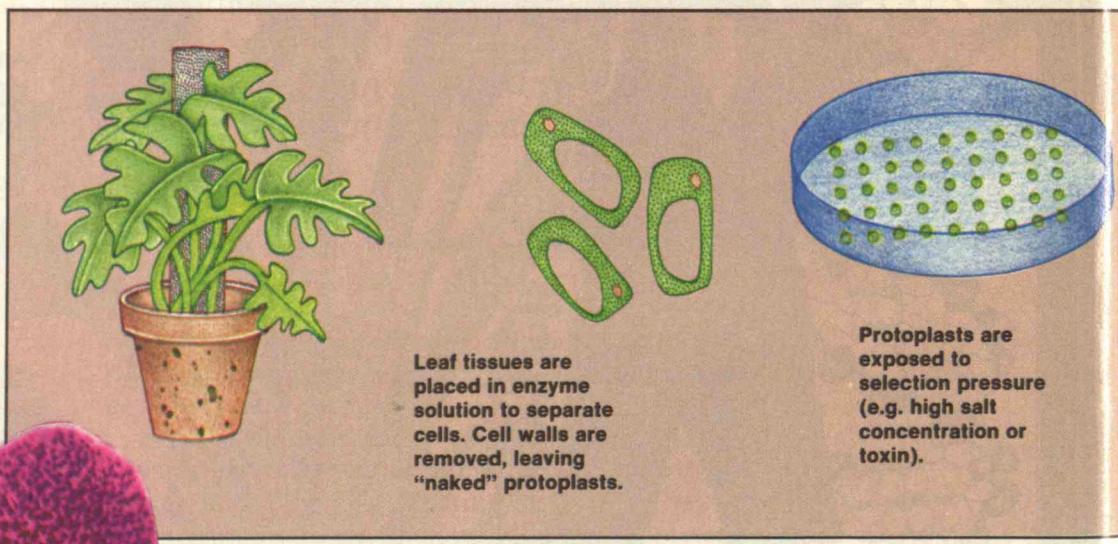
Recombinant DNA:

Recombining genes from one species with those of another



Tissue culture:

Growing whole plants from single cells.



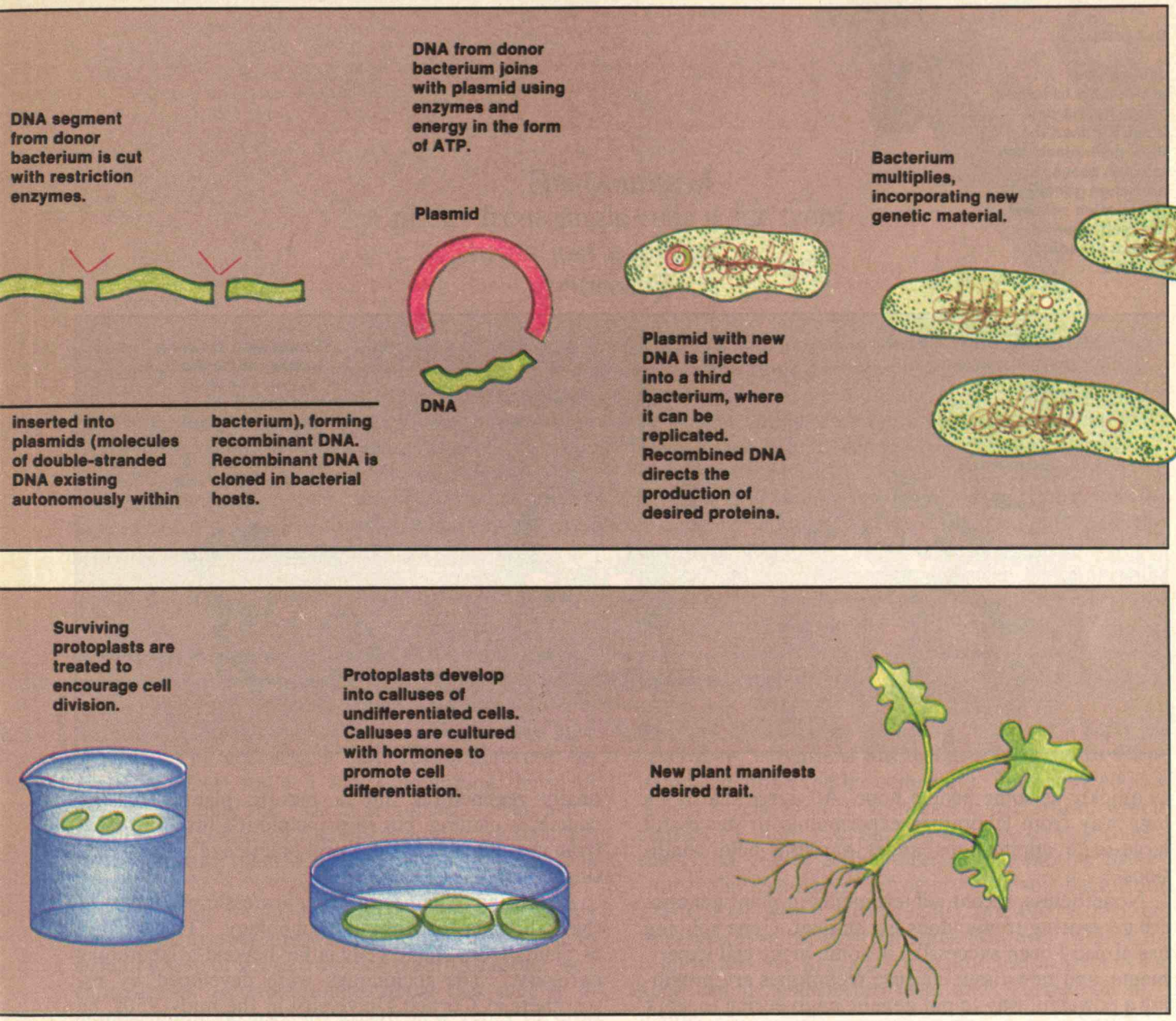


But some of the most exciting, important, and challenging developments from genetic engineering are expected to come from agriculture, where the opportunities and potential impact are enormous. Some possible applications of genetic-engineering techniques being pursued in the United States, Europe, China, and Japan include:

☐ Making food crops more resistant to diseases and insect pests. Disease resistance is often conferred by a single gene, and single genes may be relatively easy to move from plant to plant.

☐ Creating hardy new crop plants capable of thriving in salty soils or that can withstand periods of drought. This is particularly important because much

PHOTOGRAPH: © 1982 CHARLES MARDEN FITCH



DAN COLLINS

of the world's best cropland has already been ruined by the salt carried by irrigation water. Also, marginal agricultural lands where rainfall is sparse may become productive through the planting of new water-thrifty plants.

☐ Giving staple food crops such as corn, wheat and rice the ability to make their own nitrogen-rich fertilizers. In effect, this would entail using solar energy to make ammonia directly from the air.

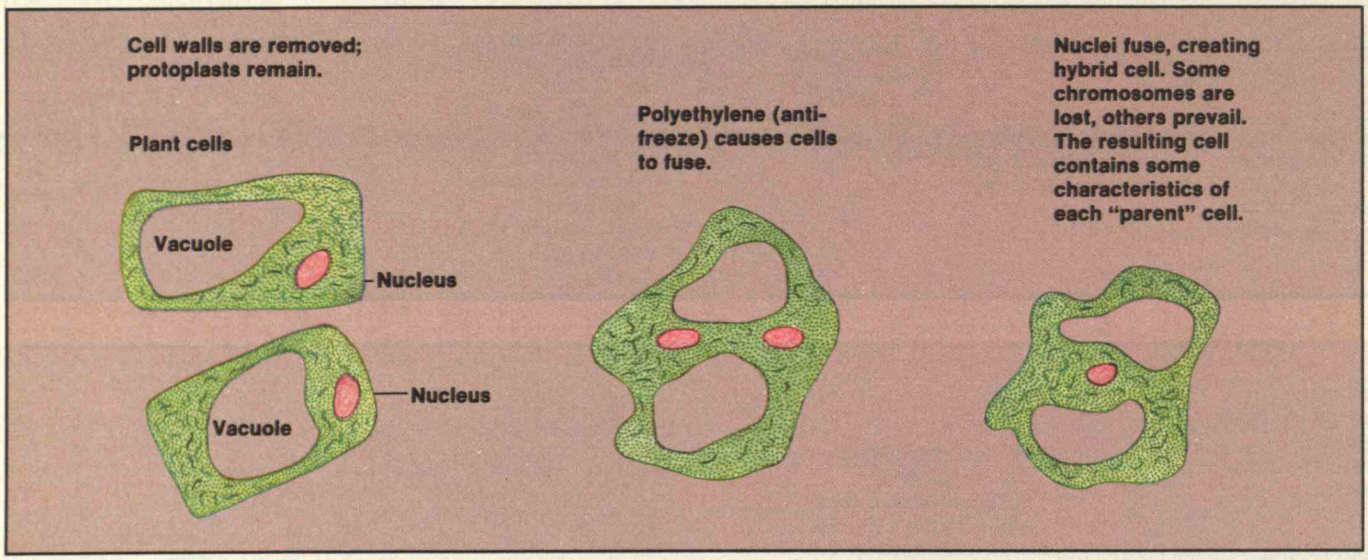
☐ Increasing crop yields by improving the way plants use the sun's energy during photosynthesis.

"The ultimate power of this technology for plant-science," says Raymond Valentine, professor of biology at the University of California at Davis, "is that it provides a tool for the transfer of any gene from any source into plants." Speaking at M.I.T.'s annual Underwood-Prescott Awards symposium, Valentine said that controlling resistance to "crop diseases and pests—including viruses, bacteria, fungi, nematodes, insects, and weeds—represents the most important area of genetic-engineering research in agriculture."

Despite rapid advances in agricultural molecular biology, however, no practical applications of recombinant DNA technology for crop improvement are yet available. Indeed, many agricultural specialists, particularly those in the plant-breeding sciences, remain skeptical about the prospects that much can be achieved. Others argue that the results won't appear

Cell fusion:

Joining two protoplasts to form a single hybrid cell. When induced to fuse, protoplasts can, in some cases, exchange genetic information without the restriction of natural breeding barriers.



DAN COLLINS

as quickly as some people hope. All agree that it's a long way from laboratory experiments to successful large-scale applications under variable field conditions.

Nonetheless, recent achievements in plant genetics are generating tremendous excitement. Gene-splicing has already been successful in some plant-cell experiments, and new tissue-culture techniques are providing a powerful way to put genetic engineering to work as well.

As Ye Clone, So Shall Ye Reap

The importance of tissue-culture techniques—which allow whole plants to be grown from single cells—is difficult to exaggerate. Tissue culture opened whole new areas of research and development even before gene transfer became so promising; together the techniques could be powerfully synergistic.

Tissue culture involves isolating single somatic cells from, say, a pine tree, putting the cells into an appropriate medium, and allowing them to divide. Given the proper hormones and suitable growing conditions, each cell goes through several intermediate steps and finally regenerates into a mature plant. This, of course, is cloning, but in principle it's little different from the standard agricultural practice of rooting cuttings.

According to James Bonner, professor of biology at the California Institute of Technology, "This cloning of plants from single cells is far beyond a laboratory curiosity." The techniques were developed by researchers at Cornell University in the mid-1950s, he explained, and have progressed so far that now most orchids, Boston ferns, African violets, oil palms, and a vast number of forest trees are being grown this way.

Bonner, speaking at a recent meeting of the National Academy of Engineering, added that by combining genetic engineering and tissue-culture techniques, "We can hope to isolate a gene, put it into a single plant cell, and then regenerate that plant cell into a whole plant, a whole field of plants, a whole crop of plants, a whole world of plants containing the new, desired quality."

Another impressive application of plant tissue culture is in the development of hybrids. A plant that results from the crossing of two highly inbred strains



The cloning of plants from single cells is far from being just a laboratory curiosity.

is, Bonner said, vastly more vigorous and productive than either parent. For example, in corn this "hybrid vigor" can be so dramatic that farmers can't afford to grow anything but hybrid varieties. The pace at which highly inbred lines of parent plants can be produced has been quickened by the application of tissue-culture techniques. Scientists can now produce inbred lines in a year or less, and these lines can be crossed to generate plants with maximum vigor.

A Fruitful Merger

Cell fusion is another technique that should play an important role in future crop development. It involves uniting the cells of species that wouldn't normally mate to create new types of plants different from both "parents." To accomplish this, researchers use enzymes to digest the cell wall surrounding the plant cell, leaving only the "naked protoplast." Protoplasts of different species are then made to fuse into a single cell by treating them with the chemical polyethylene glycol.

Cell fusion might be used for creating highly unusual plants, perhaps when moving a single gene or a small group of genes from one plant to another isn't enough. For instance, Bonner noted that such techniques might be used to create new types of crop plants that are very tolerant of drought conditions. He said that most crop plants require large amounts of water for maximal yield, but that succulents, such as pineapples and cactus, require only one-seventh to one-tenth as much water per unit of dry weight manufactured by photosynthesis as most crop plants.

This is because unlike those of most plants, the tiny pores on the underside of the succulents' leaves close when the sun rises and remain closed during the day, preventing the outward flow of water, carbon dioxide and oxygen. These pores, called stomates, open at night, allowing the leaves to take in carbon dioxide when the risk of losing water to evaporation is minimal. Huge stores of carbon dioxide accumulate until the sun comes up and the stomates close again. The stored carbon dioxide is then photosynthesized to sugars via the same pathway used by the nonsucculent plants.

"If we could incorporate succulent metabolism into other crop plants—wheat, for example—we could increase the wheat-growing areas of the world by a factor of two or three or four," Bonner said, adding that the technique could also "make reliable agriculture possible in the vast reaches of Australia, West Africa, and South America, and even make agriculture reliably productive in such disaster areas as India."

Genetic Transfer

Another approach to enhancing a plant's ability to survive dry conditions was recently reported by Raymond Valentine and his colleagues. They isolated and cloned a gene from a *Salmonella* bacterium, which confers the ability to survive in salty or dry conditions. This gene was then inserted into another bacterium—the free-living, nitrogen-fixing soil bacterium *Klebsiella*—which subsequently showed a marked tolerance to saline environments. However, while this is an impressive first step, it is not clear whether this gene can be transferred into, and "turned on in," plants.

Another gene Valentine and his colleagues have isolated and cloned is the Hup (for "hydrogen uptake") gene, which apparently helps nitrogen-fixing bacteria use energy efficiently. The goal is to insert this gene into the nitrogen-fixing *Rhizobium* bacterium, which lives in the nodules that form on the roots of leguminous plants such as beans and peas. These extra-efficient bacteria could then be painted onto soybean seeds before planting. Scientists hope that a soybean plant aided by these more efficient bacteria would have more energy to spend on making edible seeds.

The first-generation transfer of genes between plants was accomplished by a team of scientists at the University of Wisconsin that created what is now



The most compelling goal is to trick important plants such as corn, wheat, and rice into making their own fertilizer.

known as the "sunbean." Researchers John D. Kemp and Timothy C. Hall transferred the gene responsible for producing the seed protein, phaseolin, from its normal location in the French bean into a sunflower cell.

"The genetic transfer," Kemp said in a Department of Agriculture publication, "is the first step in what may become an extremely versatile and useful model system for genetically engineering plants." This experiment "may open the way for creating genetic variations now unavailable because of sterility barriers between species and [between] genera."

The sunbean transfer was made with the help of a vector—an organism that carries the gene and inserts it into the host cell, integrating it into the cell's store of genetic information. In this case, the bacterium *Agrobacterium tumefaciens* was used to transfer the new bit of genetic information into the sunflower cell. This bacterium causes crown gall, a form of tumor, but it also contains a very useful ring of genetic material called the Ti plasmid. This bit of DNA can be inserted by the bacterium into plants, causing the host's cells to produce substances such as octopine and nopaline, which are needed by the bacterium. Hence, *Agrobacteria* conduct a form of genetic engineering as part of their natural life cycle.

To make sunbeans, the Ti plasmid was used to ferry the bean's protein storage gene into the sunflower cell. The experimenters reported that the transferred bean gene seemed stable in its new sunflower-cell environment, and there were signs it was being "read" or transcribed by the cell's gene-reading machinery to produce small amounts of the messenger molecule, RNA. The next step is to alter the Ti plasmid so that it transfers specific DNA into the plant cell but lacks the gene that causes crown gall disease.

The Self-Sufficient Plant

Impressive as this work is, perhaps the most compelling near-term goal of agricultural genetic engineering is the effort to trick important plants such as corn, wheat, and rice into acting like legumes in that they make their own fertilizer. One idea is to engineer these valuable cereal plants so that they, too, can set up symbiotic housekeeping with the nitrogen-fixing *Rhizobium* bacteria.

Most researchers feel that this goal lies far in the distance. Nonetheless, a great deal of work is already being done toward making it a reality. For example, the entire 17-gene set of Nif (for nitrogen-fixing) genes has been stably integrated into yeast cells. This achievement, reported in the *Proceedings of the National Academy of Sciences*, was accomplished by a team working in Cornell University's Boyce Thompson Institute for Plant Research. The genetic information in the Nif genes wasn't expressed in the yeast cells, but the genes did maintain their ability to direct nitrogen fixation. When removed from the yeast and inserted into the bacterium *E. coli*, the Nif genes became active again and made *E. coli* into a nitrogen fixer. Once a way has been found to "turn on" the Nif genes inserted into yeast cells, the next goal will be to transfer them into higher organisms such as fungi.

Researchers hope that the lesson learned from these and other experiments may ultimately be applicable in higher plants. The growing commercial interest in agricultural genetic engineering has already directed a substantial flow of private money into such investigations. New companies such as the International Plant Research Institute (IPRI), Calgene, Agrigenetics Corp., and Phytogene have recently been established—most of them in California—to fund the research and, eventually, to exploit the results. From these and publicly supported efforts, much should be learned in the coming decades of these fascinating—and promising—technologies that together make up what has come to be called the "Second Green Revolution."

Robert Cooke is science editor of the *Boston Globe*.

Recombinant DNA: The Ups and Downs of Regulation

by Barbara Goldoftas



GEOFFREY MOSS

In the short span of seven years, recombinant DNA research has substantially improved its public image. Doctored bacteria that caused alarm when they first colonized laboratory dishes seem much more benign now that they hold commercial promise for producing vats of medications and industrial chemicals.

In the "old days," scientists created apt metaphors to explain gene splicing, and citizens in university towns gathered in lecture rooms to learn about what might be a highly threatening technology. The technique that could so indiscriminately mix and match genetic material suggested to the public—as it had to the scientists several years before—novel organisms, accidents, and abuses that needed control.

But now, in response to the lead of researchers, the new biology is generally seen as a "biotechnology"—a tool to help cure genetic diseases, lower production costs, and create plants that make their own fertilizers. Controls on recombinant DNA research have been developed, but as scientists have changed their minds about the value of controls and the public has lost interest, the controls have gradually been weakened. This past winter the remnants of an unprecedented set of guidelines were nearly discarded for a voluntary code, indicating that in spite of its questionable past, recombinant DNA has become legitimate.

Sentenced to the RAC

The first fears about recombinant DNA were expressed by biologists: they worried about creating new forms of life that might harm public health and the environment, especially since the ubiquitous bacterium *Escherichia coli* was being used extensively to host new genes. *E. coli* often infects laboratory workers in ordinary research because it thrives in the human digestive tract. It was also feared that such bacteria might escape from the laboratory, not only in infected researchers but hidden in hair or the fold of a lab coat. Some recombinant DNA scientists worried that escaping bacteria spliced with new—and perhaps even toxic—properties could survive and multiply outside the laboratory, generating an epidemic. Moreover, the new hybrids might prove to be superorganisms that could dominate other organisms, create new niches in the ecosystem, upset the ecological balance, and fundamentally alter the gene pool.

Some scientists also feared that recombinant DNA techniques would be abused or applied in harmful or disruptive ways. Given that the medical field already emphasized genetic rather than environmental ills, they suspected that the tool would be used to "tailor" human genes. Recognizing the "great and terrible power" of the new recombinant DNA techniques, biologist Robert Sinsheimer (currently chancellor of the University of California at Santa Cruz) advised a forum of the National Academy of Sciences in 1977: "Let us not design a technology fit only for a rational, farsighted, unerring, and incorruptible people."

These fears were first shared with the public in 1974, when biologists organized and honored a voluntary, worldwide moratorium on research considered most hazardous. In 1975, an international group of scientists, social scientists, and attorneys met at the Asilomar Conference Center in Monterey, Calif. to discuss recombinant DNA and its hazards. The debate was so prolonged and heated that a consensus seemed impossible, but the participants finally approved a set of restrictions to guide research until formal guidelines were created. Specific hazards had not yet been demonstrated, but the researchers agreed that uncertainty about recombinant DNA warranted caution. Besides, many scientists also realized that if they themselves didn't implement rules, individual communities would become alarmed and create their own, and the resulting patchwork of local legislation could disrupt or cripple research.

At this point, partly in response to advice from a National Academy of Sciences panel, the regulatory initiative shifted from scientists to the arm of government primarily supporting their work—the National Institutes of Health (NIH). The NIH created several committees and facilities, most notably the Recombinant DNA Advisory Committee (popularly known as the "RAC"), to address the scientific issues raised by recombinant DNA. The committee was not instructed to examine social or ethical issues.

In 1976, the RAC completed a set of guidelines reflecting the Asilomar restrictions. The guidelines were based on "worst-case" scenarios—epidemics, irreversible ecological disruptions, and the deliberate

Many scientists realized that if they themselves didn't implement rules, individual communities would become alarmed and create their own.

abuse of the technology to create, for example, genetically superior beings—and how they could be prevented. But such an approach emphasizing avoidance of disasters did not include the prevention of subtle or gradual complications.

The guidelines prohibited experiments believed to present clear risk, including work with various pathogens or toxins and large-scale production of recombinant organisms. They prohibited the deliberate release or dissemination of recombinant organisms—such as outdoor tests of genetically engineered bacteria to fight pests—for fear of losing control of the bacteria. And the guidelines mandated that experiments be controlled through biological and physical "containment" to prevent the escape of organisms from the laboratory.

Biological barriers consisted of combinations of "disabled" host bacteria (unable to live outside the laboratory) and similarly crippled "vectors" (that transfer the DNA) capable of growing only in certain hosts. The rules for physical containment specified four levels of laboratory conditions and safeguards: standard microbiological practices (P1) that bar eating, drinking, smoking, and mouth pipetting for experiments of minimal risk; slightly more stringent laboratory conditions (P2) requiring sterilization of wastes; separate negative-pressure facilities (P3); and a high-security laboratory (P4), similar to that used for biological weapons research, to contain work with extremely hazardous organisms.

The RAC assigned each type of recombinant DNA experiment a pair of biological and physical containment levels believed to match the estimated short-range risk. In addition, the guidelines established a review process in which principal investigators, the research institute's biosafety committees, and the RAC would participate. Scientists who failed to comply could lose their funding.

Red Tape and Remnants

These guidelines became controversial almost immediately. Many environmentalists and scientists without a professional stake in recombinant DNA biology declared them inadequate. They charged that the guidelines, written primarily by biologists determined to continue their research, were self-serving and scarcely addressed the social or long-term effects that could ultimately prove most dangerous. Erwin Chargaff, a DNA chemist then at Columbia University and an outspoken critic of the research, suggested that "this was probably the first time in history that the incendiaries formed their own fire brigade."

But most recombinant DNA researchers claimed the opposite. Objecting to the mandated penalties and public involvement, many resented the guidelines as unnecessary red tape. "They have put every recombinant DNA scientist in jeopardy of making trivial paper violations that in no way create a safety problem but that can draw serious penalties on him and his institution," complained Wallace Rowe, an NIH biologist well-known for his risk-assessment experiments on recombinant DNA. Furthermore, some researchers claimed that recombinant DNA was safer than scientists originally had thought. Norton Zinder, a biologist at Rockefeller University and consultant to the RAC, recently asserted that he hasn't perceived safety as an issue since 1977. Molecular biologists had spoken up earlier, he claimed, because they had "frightened themselves with their newfound powers."

When congressional bills aimed at restricting the work were introduced in 1977, pro-recombinant DNA scientists lobbied against them. The lobby was intended only to weaken the bills, but it succeeded in defeating them altogether, leaving regulatory responsibility to NIH or local government.

The pro-recombinant DNA lobby gradually succeeded in weakening the RAC guidelines as well, and the overall trend has been to streamline safety measures and reduce the RAC's authority. Major changes in 1978 and 1980 permitted research with organisms other than the familiar *E. coli*, reduced most containment levels, exempted experiments believed to present the lowest risk, and shifted responsibility for the review process from NIH to the research institutions.

(There were also a few small changes in the other direction. The RAC was empowered to review containment measures for researchers supported by industry, or other non-NIH sources, who chose to comply voluntarily with the restrictions. And Joseph Califano, then-secretary of the Department of Health, Education, and Welfare, increased public participation in the oversight process by expanding the RAC to include nonscientists. But although the more varied membership broadened the scope of the committee, the RAC's duties remained confined to technical issues.)

However, by 1981, only the remnants of the original system of detailed rules and regulations remained. At least 95 percent of all recombinant DNA research was exempt from restrictions, and those experiments requiring approval were quickly reviewed through institutional committees before registration with the NIH. Certain types of experiments were still nominally prohibited, but even those could be approved after case-by-case review.

A Modest Proposal

The RAC began another round of debates in 1981, this time on whether to reduce the guidelines to a voluntary code. In September, the committee recommended—and published in the *Federal Register* for public comment—an extreme set of revisions, replacing penalties and prohibitions with admonitions and removing all procedures to register and oversee research. Its authors were two biologists long involved with recombinant DNA: Alan Campbell of Stanford University and David Baltimore of the Massachusetts Institute of Technology, a RAC member, and director-designate of the privately endowed Whitehead Institute.

The proposals would have permitted scientists to conduct all experiments—except work with pathogens regulated by the Center for Disease Control—under standard laboratory conditions (P1). Although the committee proposed retaining the RAC for "social and political" purposes (to reassure the public that a watchdog mechanism remained), it recommended removing all mandatory requirements.

The RAC's proposed revisions reflected what many scientists had come to believe: that six years of research and experiments on the potential infectivity of spliced *E. coli* had proven recombinant DNA to be harmless. "Nothing more dangerous has come out of the work than what went into it," concluded William Gartland, director of the Office of Recombinant DNA Activities within the NIH and executive secretary of the RAC. "The record warrants lowering of containment." The group did not necessarily believe unique hazards do not exist, he observed, only that the historical record showed that risk to be insignificant.

Other scientists, including some RAC members, countered that the six years of experiments provided "purely anecdotal" evidence of safety. They noted that safety depends on conditions within individual laboratories, that work thus far could not indicate delayed or long-term effects, that the results of risk-assessment experiments

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So far, new biotechnology firms have voluntarily abided by the NIH guidelines, but there is no assurance that they will continue to do so.

have been difficult to interpret (if not *mis*-interpreted to be more reassuring than they are), and that other organisms may respond differently than *E. coli*. Washington attorney Patricia King, a member of the RAC, called voluntary compliance "the worst of all possible worlds. You achieve none of the objectives of regulation and none of the benefits of being unregulated. All you're saying is: 'I give a stamp of approval to what I see here before me without any authority to do anything.'"

In a report last October to the Governor's Molecular Biology Task Force in Michigan, Susan Wright, a historian of science at the University of Michigan, concluded that the "variation in containment requirements and in stringency of controls now being applied in different countries [shows that] consensus on the significance of the risk-assessment experiments has not been achieved in the international community." She cited the United Kingdom as an example. There the regulatory system requires medical monitoring, long-term epidemiological studies, prior review of recombinant DNA experiments, and periodic inspection of research facilities, as well as containment levels that tend to be higher than those in the United States.

An additional issue that split the RAC in September was whether the committee itself should continue to exist. Dr. Zinder explained in an interview that the RAC should be dissolved because "it serves no purpose, and as long as it continues to exist it points a finger that there may be real danger out there." But Susan Gottesman—senior investigator in molecular biology at the National Cancer Institute, former RAC member, and chairwoman of a RAC working group that reviewed the guidelines last summmer—offered another perspective. The RAC should remain, she said, because uncertainty remains and a mechanism is needed to filter out careless or high-risk work.

The Only Game in Town

Dissatisfied with the RAC's proposed revisions, Dr. Gottesman independently submitted an alternate proposal that appeared in the *Federal Register* in December. It, too, simplified the restrictions and eased containment requirements, but it required that the guidelines remain mandatory and that the institutional committees, as well as some prohibitions on experiments, be retained. For example, prior review and approval would still be required for experiments that clone genes for toxins (such as for diphtheria and botulism) and those conferring pathogens with resistance to antibiotics. Such experiments could lead to the creation of supremely toxic organisms or pathogens invulnerable to treatment by antibiotics. Dr. Gottesman also proposed that the dissemination of recombinant organisms into the environment continue to be restricted. Otherwise, experiments previously requiring approval by NIH would need review only by institutional committees.

The RAC received some 150 letters commenting on the two proposals. Although initial responses supported the committee's recommendation of voluntary guidelines, later correspondence swung the overall response toward the more conservative proposal. Some scientists, including Wallace Rowe of M.I.T. who had earlier pressed for greater relaxation of the guidelines, gave their support to mandatory controls on the three areas of research that the Gottesman proposal would restrict.

An even more important sign, however, was the resurgence of interest in local regulation. In California, for example, where a large percentage of recombinant DNA work occurs, the chairman of the state assembly's Health Committee promised that if the mandatory guidelines were removed, the state would act to fill the void. In the Boston area, where three communities have already passed ordinances regulating recombinant DNA research, members of two biosafety committees at Harvard University wrote to oppose the RAC's proposal. The committees were concerned that the cities of Boston and Cambridge would strengthen their ordinances if the NIH guidelines became voluntary.

When the RAC met in early February, it withdrew support of the changes recommended earlier and, after little debate, approved Dr. Gottesman's more conservative proposals.

Evidently, both the RAC and some communities acknowledge that the influence of the NIH guidelines extends beyond the universities. Voluntary guidelines would leave the young biotechnology industry virtually free of restrictions, and although NIH cannot control industry because it lacks true regulatory power, it offers the sole federal guidance available. Only a few other agencies could have any authority over recombinant DNA work, and each is restrained by limits on its authority and recent funding cutbacks.

For example, the Food and Drug Administration will regulate new recombinant DNA products within its purview, but that agency cannot oversee their research and development. And the Occupational Safety and Health Administration (OSHA), which could play a role in these earlier stages, has not yet done so. In a letter to Donald Frederickson, then director of NIH, in 1979, former OSHA Assistant Secretary Eula Bingham expressed concern about potential health hazards to workers exposed to recombinant DNA. However, she said that the agency could not develop specific regulations for at least two years. Today OSHA is seriously hampered by an administration unsympathetic to regulation and labor interests, as well as by a backlog of cases on immediate occupational dangers. Neither agency representatives nor RAC members expect any involvement by OSHA in the near future.

So far new biotechnology firms have voluntarily abided by the NIH guidelines, but there is no assurance that they will continue to do so or that they would follow voluntary restrictions for universities. Furthermore, laboratory research and risk-assessment experiments—the basis for the weakening of the guidelines and the subsiding of the public outcry—do not provide sufficient proof that controls for large-scale work are unnecessary. In the absence of the involvement of any other federal agency, the RAC and the NIH guidelines still have important roles to play. □

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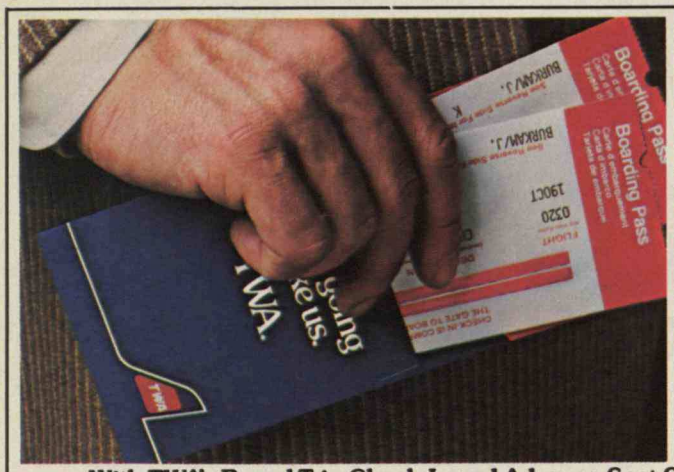
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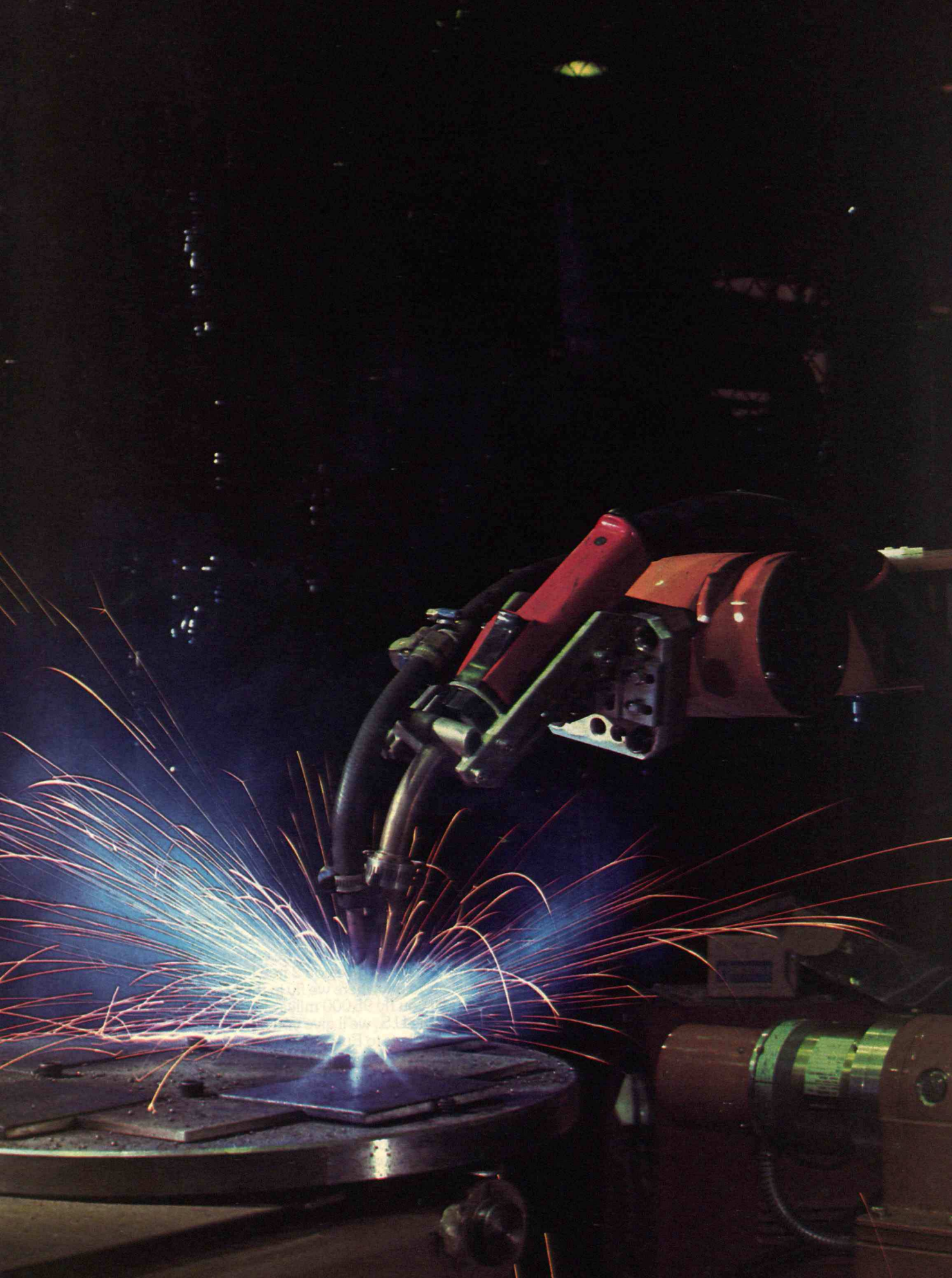
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Industrial Robots on the Line

by Robert Ayres and Steve Miller

Industrial robots are proliferating on the assembly line and decreasing the cost of manufactured goods. But the workers they displace must be retrained.

INDUSTRIAL robots are not humanlike androids that stroll around and converse as R2D2 did in *Star Wars*. They are machine tools—programmable manipulators that can move parts or tools through prespecified sequences of motions. Like more familiar machine tools, a robot can repeat the same task for prolonged periods with great precision, but a robot's tasks can be extremely complex. Moreover, a robot can be "taught" new tasks and use accessory tools to extend its range of abilities. State-of-the-art robots—mostly in research labs—even have crude senses of "sight" and "touch" and limited capability to coordinate their manipulators with sensory information.

As yet, robots at work in industry cannot react to unforeseen circumstances and changing environments, nor can they improve performance based on prior experience. Because of these limitations, today's robots are mostly used in repetitive, "preprogrammable" tasks such as spot welding, grinding, spray painting, stacking, and the loading and unloading of machines.

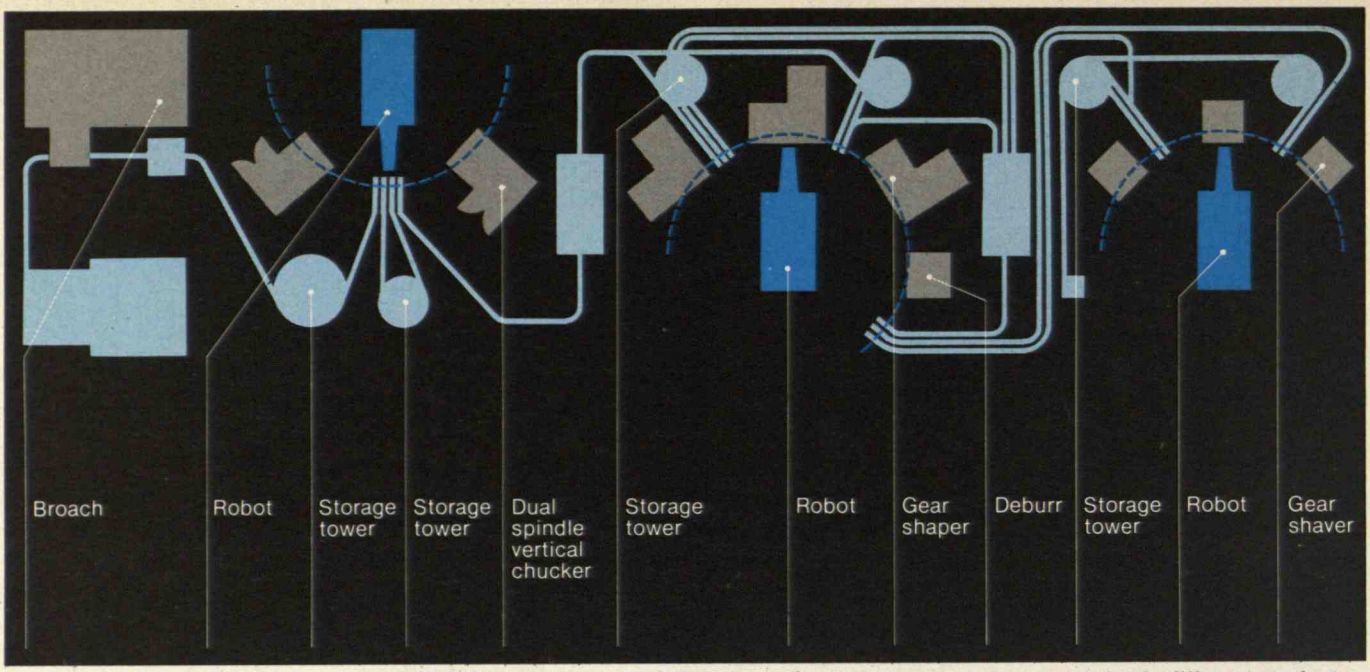
The next generation of robots will have greatly improved vision and sensory feedback, enabling them to perform many more of the tasks still performed by production workers on the factory floor. Thus, robotics has the potential to greatly increase productivity and wealth but also promises significant social impacts, such as displacement of workers and shifts in the structure of the world economy.

Throughout history, societies have functioned by forcing large numbers of people to perform dull, dirty, dangerous, and demeaning but necessary tasks. Factories, in particular, have traditionally used humans to handle materials, load and unload machines, operate tools, and assemble parts. Such tasks make use of human motor skills and eye-hand coordination but often require little judgment or creativity.

Robots can fill such jobs, providing an immediate overall societal benefit. In a particularly exotic example, robots may someday be used to handle dangerous radioactive materials, including wastes in disposal facilities. Such a robot was built in 1958 by Hughes Aircraft to handle radioactive materials at the Atomic Energy Commission facilities in Albuquerque, N.M. Mobile robots would also be extremely useful in exploration, mining, construction, and maintenance and repair work. For example, the U.S. Department of Energy is currently evaluating the potential of robotics in nuclear reactor maintenance, and the navy and others are actively developing unmanned submersibles—a kind of robot—for both military and civilian purposes. If we succeed in creating orbiting space colonies or industrializing the moon, asteroids, and other planets, it will be with major assistance from robots. The *Viking 2* lander that touched down on Mars in September 1976 was the first of such exploration robots, and similar extended missions are now being planned.

Future robots may serve disabled people such as paraplegics, and especially quadriplegics, full time. For example, voice-activated robots now being developed in the U.S. and Japan might eventually perform a variety of tasks from feeding to page-turning.

In 1978, Quasar Industries of Rutherford, N.J.,



A computerized system for manufacturing gears. Three robots serve "work cells" composed of several metalworking machines. All robots and machines are linked via microprocessors. In principle, such a system could be reprogrammed to produce completely different products, although it would be unlikely in this particular application.

announced its intention to mass-produce a household android "within two years." The project was a hoax but stimulated press interest, if only because of the vast potential market. And Nieman-Marcus Department Stores introduced a household "robot"—actually a remote-controlled device—in their 1981 catalog. Meanwhile, Joseph Engelberger, president of Unimation, the largest U.S. manufacturer of robots, has promised he will soon have a robot (to be named Isaac, after Asimov) that will serve coffee in his office.

Robotic Roots

The term *robot*, from the Czech word *robota*, or serf, was popularized a half-century ago by Czech playwright Karel Capek in his play *R.U.R.* But the concept of programmable machinery dates back to eighteenth-century France, when Bouchon, Vacaunson, Basile, Falcon, and Jacquard developed mechanical looms controlled by punched cards. In the United States in the mid-nineteenth century, Christopher Spencer invented the Automat, a programmable lathe that made screws, nuts, and gears. Its cutting patterns could be varied with interchangeable cam guides fitted to the end of a rotating drum. Mechanical controls were standard in the machine-tool industry until the 1950s.

Mechanical manipulators also have a long history. In 1892, Seward Babbitt of Pittsburgh patented a rotary crane with a motorized gripper for removing hot ingots from furnaces. The first jointed mechanical arm (specialized for spray painting) that could repeat a series of preset motions was developed by Willard Pollard in 1938.

But the robotic age really began in 1946 when George Devol developed a general-purpose playback device for controlling machines. And in 1954, Devol patented the first manipulator with a playback memory that controlled movements from one point to subsequent points. Devol's early patents were sold to Consolidated Diesel Corp. (Condec) and led to the formation of Unimation, Inc., Condec's robot division (*see opposite page*). Between 1954 and 1963, Devol and several others patented the major features of the first generation of robots.

These early robots had computerlike functions such as electronic memory, but the pertinent components were permanently wired to perform specific sets of tasks. Software-controlled robots were not commercialized until the early 1970s. The first—controlled by a minicomputer—was offered in 1974 by Cincinnati Milacron, and microprocessor-controlled robots followed several years later. Such "soft-wired" robots—really specialized "peripherals" of general-purpose computers—enjoy the benefits of huge amounts of "memory" or data storage, and are consquently far more flexible than machines controlled only by specialized electronic logic circuits. The best of today's robots can work in several coordinate systems, are easily reprogrammed, utilize sensors, and to some extent respond to variations in "real time"—that is, as they occur.

How Many Are There, and Where?

Industrial robots in the United States are undergoing a virtual population explosion; their numbers have increased from 200 in 1970 to about 4,500 today. At the end of 1980, almost 30 percent of the U.S. robot population was owned by only six firms, three in the

The Robot Man

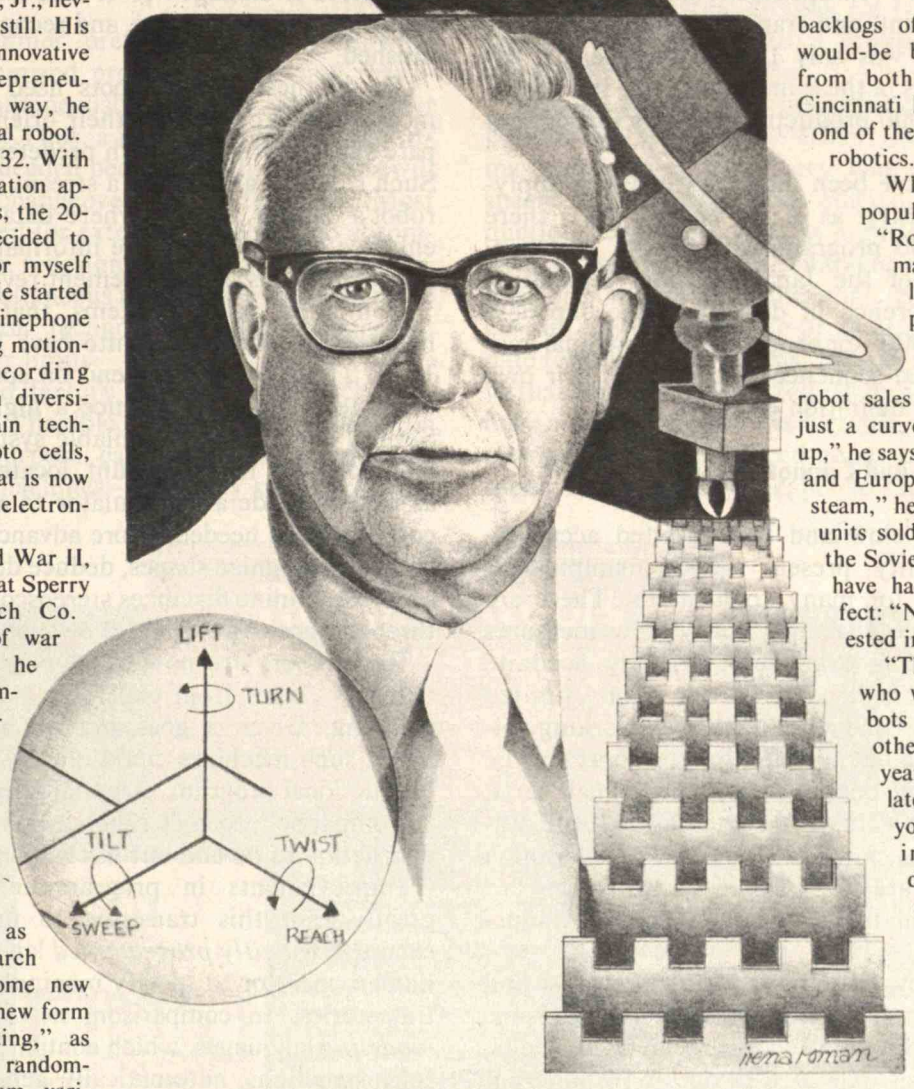
GEORGE C. Devol, Jr., never could stand still. His career is a blur of innovative technological entrepreneurism, and along the way, he invented the industrial robot.

It all started in 1932. With the fire of determination appropriate to his years, the 20-year-old inventor decided to "go into business for myself instead of M.I.T." He started by forming United Cinephone Corp. and developing motion-picture sound-recording equipment. He soon diversified: "I used certain techniques, namely photo cells, and pioneered in what is now called the industrial electronics field."

Just before World War II, he spent a few years at Sperry Gyroscope Research Co. With the coming of war came opportunities: he organized a new company, General Electronics Industries, and made radar test equipment, radar countermeasures systems, and "special projects for OSS."

After the war, as owner of Devol Research Co., he patented some new ideas "concerning a new form of magnetic recording," as well as a large-scale random-access memory system, various types of control systems, sensors, and ultra-high-speed printers.

The year 1954 could well be called the year of the robot: that was when George Devol patented "universal automation," or "unimation" for short. Some 40 patents in all were involved in the concept, which eventually became the basis for Unimation, Inc., today a subsidiary of the Condec Corp. and the largest manufacturer of robots in the world.



It was tough going in the early days of robot sales. "You'd go around and tell someone you wanted to put a robot in their plant and they'd almost call the guards to come and get you," Devol recalls.

Only 70 hand-built units were sold during the six years after a prototype "Unimate" was built in 1960. But Condec had a hunch that a market had finally developed, and in 1966 made the decision to tool up a mass-production line. Today, backlogs of orders frustrate would-be buyers of robots from both Unimation and Cincinnati Milacron, the second of the U.S. "big two" in robotics.

Why are robots so popular? Says Devol: "Robots do not just make a product for less money; they produce a better product."

The future of the robot sales curve? "It's not just a curve; it goes straight up," he says. Sales in the U.S. and Europe are "going full steam," he reports, and a few units sold by Unimation to the Soviets a few years ago have had the desired effect: "Now they are interested in buying more."

"There isn't anybody who won't be using robots in some form or other in the next 15 years," Devol speculates. "I can assure you that you're going to see the damnedest explosion."

The Devol story is far from over. He recently formed Devol Research Associates in Fort Lauderdale, and the news section of *Industrial Robots International* reports: "George Devol, the man whose patents underlie the robot industry, is looking for the financial backing needed to make robots fulfill their multi-billion-dollar potential."

He never was a man who could stand still.—*L.A.P.* □

Future robots may serve disabled people such as paraplegics and quadriplegics full time.

auto industry. However, robot use has spread to a larger number of firms over the past several years.

Most potential robot users fall within a group of five industries known as "the metalworking sector." As specified by the Standard Industrial Classification Code, the five are primary metals, fabricated metal products, machinery (except electrical), electrical and electronic equipment, and transportation equipment. As of 1980, there was only 1 robot for every 1,300 production workers in these industries, and less than 1 robot for every 3,000 production workers throughout all manufacturing.

The Japanese have been more aggressive in applying robots to industry: as of the end of 1981, there were nearly 14,000 programmable robots in Japan. Larger estimates of the Japanese robot population stem from a difference in definition: the Japanese include some 65,000 nonprogrammable manual manipulators and fixed-sequence machines in their own total, but the U.S. definition excludes these.

What Robots Can and Cannot Do

Because they are slow and have limited accuracy, force, and versatility, present robotic manipulators are unsatisfactory for many applications. There are also significant trade-offs among the various measures of performance. For example, extremely accurate robots with very small payloads allow only limited kinds of movements and a relatively tiny working volume. Such accurate but motion-limited robots may be appropriate for some operations with very small parts, such as assembling watches and cameras. On the other hand, robots that can move large payloads through greater distances are not usually very precise, but they can be useful in heavy manufacturing industries.

Robots' accuracy is limited by the precision and durability of their power transmission mechanisms, such as hydraulic lines and valves, gear trains, belts, chains, and linkages. All such devices have inherent slop, and they wear with use, making things even more difficult for the control system. New robot designs, such as a direct-drive electric manipulator developed at Carnegie-Mellon University, eliminate transmission mechanisms and pave the way for a new generation of lightweight, high-performance robot arms.

Most robots in use today must be "taught" or "walked through" a task in complete detail. However, many industrial tasks such as welding, grinding irregular surfaces, cutting logs, and fitting pieces of cloth together require adjustment as the task proceeds. Such tasks are easy for humans but exceedingly difficult for robots, which must be able to sense key attributes of workpieces to make the necessary adjustments. Robots must also be able to know when a workpiece is damaged or of inferior quality, perhaps removing it from the line, and recognize when a job is finished.

To do these tasks, robots need sensors that can measure workpieces and their orientations and compare such information with predetermined standards. Such sensors can provide a stream of raw data to the robot's control system, where data processors filter, enhance, and interpret the information, make appropriate decisions, and implement revised instructions.

Computer vision systems that distinguish silhouettes in black and white have been in use since 1973. These systems depend on special lighting and other techniques to produce a high-contrast image. Several commercially available systems that use this technique can inspect, count, locate, and orient parts as well as guide a manipulator to an object, making corrections as needed. More advanced vision systems that can recognize shapes, deduce details in shadowed areas, determine distances stereoscopically, and see in three dimensions are under development.

Researchers are now developing robotic software that can "learn from experience" and do high-level planning. Given a goal and the necessary sensory input, such machines could modify or even create an instructional program, essentially learning on the job. In comparison, today's robots require each step of an instruction to be laid out in complete detail.

Improvements in programming languages can greatly ease this transition to more "intelligent" robots. *Explicitly programmed* languages require the human operator to specify manipulator positions and trajectories. In comparison, new high-level *world-modeling* languages, which contain simple but powerful instructions, automatically generate manipulator positions and trajectories. But such languages can be used only with robots controlled by a general-purpose computer, and very few currently installed robots have that capability. As a result, today's robots, with their limited data-processing capacity, cannot recognize and pick desired parts from bins, nor can they perform complex assembly and dissassembly work routinely.

Contrary to popular belief, American manufactured goods are not primarily mass-produced: be-

Researchers are now developing robots that can learn from experience and do high-level planning.

tween 50 and 75 percent of the dollar value of durable goods manufactured in the U.S. are "batch-produced." In batch production, a relatively small number of products are made over a period of a few weeks or months at most. Despite improvements in computer-controlled machine tools and robots over the past 20 years, most batch production is still quite labor-intensive.

Shifts in consumer preferences and a growing demand for customized products are forcing manufacturers to simultaneously increase both product variety and quality. Thus, a more flexible manufacturing technology is needed because production runs will be shorter and changeovers more frequent. Most important, the need for extensive retooling to accommodate production redesign must be reduced or eliminated. These simultaneous requirements have pushed existing production technologies and management techniques to their limits.

But a robotized factory need have no such constraints. Indeed, "flexible" automation—based on clusters of multipurpose, easily reprogrammed, computer-controlled machines—is ideally suited to batch production. But robots are not yet cost-effective in custom applications in which a great deal of time may be needed for skilled machinists to set up the machines to produce very few copies of the product. Also, the time needed to write the necessary computer programs could exceed the machine operation time. It is usually easier for a machinist to make such custom pieces manually than for engineers to "translate" the procedures into a program of instructions suitable for use by a robot.

Robots are not yet cost-effective in most mass-production applications either, because specialized mass-production machinery can operate at higher speeds and perform more efficiently. But mass-production machinery, such as high-speed transfer lines used to manufacture automobile engines and transmissions, has other limitations. Such machinery is custom built for a single product and can accommodate few, if any, variations. Indeed, an assembly line is virtually a huge specialized machine that can produce only a single product. As a result, substantive design changes in mass-produced goods are costly to implement. It is generally cheaper to scrap the specialized

Robotic Roots Revisited

A partial chronology of significant developments in robotics technology

3000 to 100 BC

Egyptians build water-powered clocks and articulated figures, some of which they regard as oracles.

Greeks, Ethiopians, and Chinese construct a variety of statues and figures capable of sequences of motion powered by steam or water.

1770s

Swiss craftsmen Pierre and Henri Jacquet-Droz construct life-like automata that can write, draw, and play musical instruments — controlled by cams and driven by spring-powered escapements. ▼



FRANKLIN INSTITUTE



THE BETTMANN ARCHIVE, INC.

1801 ▲

The first machine operated by punched cards — a programmable loom designed by Joseph Jacquard — is mass-produced in France.

1830s

Christopher Spencer develops the Automat, a cam-programmable lathe, in the U.S.

1892

Seward Babbitt designs a motorized crane and gripper in the U.S. for removing ingots from a furnace.

1921 ▶

Czech playwright Karel Capek's play *R.U.R. (Rossum's Universal Robots)* opens in London, popularizing the word *robot* — derived from the Czech word for forced laborer.

1938-39

Programmable paint-spraying machines are designed in the U.S. by Harold Roselund, working for the DeVilbiss Co., and Willard Pollard.

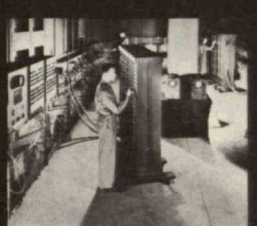
1946

In the United States, George Devol develops the magnetic process controller (a general-purpose playback device for controlling machines) and inaugurates the age of programmable industrial machinery. In the same year,



NEW YORK PUBLIC LIBRARY

J. Presper Eckert and John Mauchly build the first, large electronic computer, the ENIAC, at the University of Pennsylvania, sponsored by the U.S. Army. ▼



U. OF PENNSYLVANIA

Whirlwind, the first general purpose digital computer solves its first problem at M.I.T.

1948

M.I.T. professor Norbert Wiener publishes *Cybernetics*, popularizing the concepts of communication and control involved in electoronic, mechanical, and biological systems.

Women are less likely to be represented by labor organizations, leaving them more vulnerable to displacement by technological innovation.

machinery and rebuild the system from scratch.

Thus, mass-production would be cheaper if the capital equipment were itself mass-produced and more flexible. The virtue of programmable, general-purpose robots is that a standardized unit may be utilized in many different configurations. Specialization is achieved through changes in software rather than hardware.

The Factory of the Future

There could be no more dedicated and untiring factory worker than a robot. Robots can repeat tasks such as spot welding and spray painting flawlessly on a variety of workpieces, and they can be quickly reprogrammed to perform entirely new tasks. However, once installed a particular robot is likely to be a specialist in a particular application because of mobility constraints. Thus, the capabilities of today's programmable machines are not yet fully exploited.

In the next few years, we can expect to see many industrial robots installed in medium-batch manufacturing plants. Robots will feed workpieces to clusters of automatic machines in "work cells." Such work cells may be serialized to form a "closed-loop" manufacturing system controlled by microprocessors (*see the chart on page 36*). However, stand-alone robots will still be crucial in carrying out preprocessing functions such as cutting raw bar stock, and also for supplementary functions such as heat treating, surface plating, and assembly. Today, human operators still have to manually measure workpieces to ensure that such "closed-loop" machining operations meet specifications. Eventually, when work cells are fully automated, robots will perform such routine measurement and inspection.

The factory of the future will consist of such closed loops linked together in a flexible, computerized manufacturing system. Precursors of such systems have already been built in the United States, East Germany, and Japan. These flexible, computerized manufacturing systems could be quickly and cheaply modified to make changes to existing products and even to inexpensively produce entirely new products. In the ideal flexible manufacturing system, the average unit cost of producing one thousand (or million) copies of a product could well approach the average unit cost of producing each of a thousand different products!

1951

Raymond Goertz, working for the Atomic Energy Commission, develops a remote-controlled electrical teleoperator equipped with an articulated arm.

1952

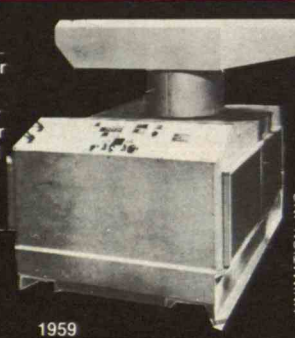
The first numerically controlled machine tool is built at the M.I.T. Servomechanism Lab.

1954

Devol develops the first programmable robot and, in describing its point-to-point control and electronic playback memory, coins the phrase *universal automation*, shortened later to *unimation*.

1958

Hughes Aircraft develops a mobile, two-armed, remote-controlled teleoperator for the Atomic Energy Commission, to be used in radioactive environments.



UNIMATION, INC.

1959

Planet Corp. builds — and sells — the first commercially available robot.

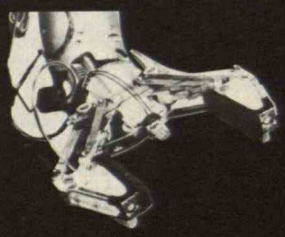
1960 ▲

Devol's patents are acquired by Consolidated Diesel Corp. (Condec), which develops the Unimate robot through its newly formed subsidiary, Unimation, Inc. (now the world's largest robot manufacturer).

Harry Johnson and Veljko Milenkovic design a programmable robot for the American Machine and Foundry Co.

1961

At M.I.T., Heinrich Ernst builds an electrically powered mechanical hand equipped with touch sensors and controlled by a computer. ▼



1962

General Motors installs its first Unimate robot on the assembly line.

Mid 1960s

Robot or artificial intelligence research laboratories open at M.I.T., Stanford Research Institute (SRI) International, Stanford University, and the University of Edinburgh.

1965

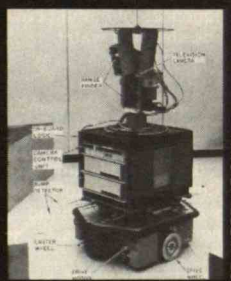
An aluminum prosthetic hand is developed by Rajko Tomovic at the University of Belgrade, prefiguring the development of remote-controlled teleoperator devices with sophisticated sensory feedback. ▼



DAN MCCOY, RAINBOW

1967 ▶

General Electric builds what proves to be an unmanageable quadruped vehicle for the Department of Defense — all four legs required simultaneous manipulation by a single human operator.



SRI INTERNATIONAL

1968 ▲

An "intelligent" mobile robot, equipped with a television camera, optical range finder, touch sensors, and the capability of deciphering English commands, is built at SRI International and named Shakey for its characteristic movement. In the

Private industry is doing very little to prepare workers whose jobs may be eliminated or substantially changed by the use of robots.

Machine utilization would be higher in robotic production systems. In comparison, manually operated machine tools in today's metalworking industries are idle far more than they are in use—from 70 to 95 percent of the time in small job shops and batch production, and between 60 and 80 percent of the time in typical mass-production plants. This downtime stems from scheduled maintenance time, incomplete use of the second and third shifts, plant shutdowns, scheduling inefficiencies, and setup time. And because of the limitations of manual materials-handling systems, there is typically a large work-in-process inventory on the shop floor.

Significantly, manufacturers' durable goods, including machine tools and other capital equipment, are almost entirely batch produced. The use of robots and computer control could greatly boost the efficiency with which such equipment is produced. Thus, the price of capital goods in relation to other production factors can be expected to decline fairly sharply over the next half-century.

It is difficult to overstate the potential significance of increased productivity on the nation's economy:

☐ Manufactured goods might become cheaper as the capital equipment used in production declines in cost.

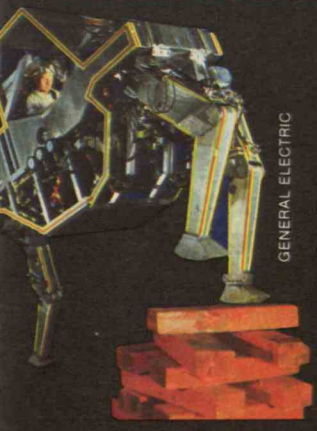
☐ Consumer demand might be stimulated by decreasing prices. But because old or worn-out items could be more cheaply replaced, that demand could take new directions. For example, people might increase their demand for educational opportunities or leisure time as their real buying power increases.

☐ A lower real cost for manufactured goods might even decrease the rate of inflation. If inflation is caused by too much money chasing too few goods, a boost in productivity could be an effective way to break out of the vicious cycle.

The Robot Revolution

As part of the recent Carnegie-Mellon University study called *Impacts of Robotics on the Workforce and Workplace*, members of the Robot Institute of America were asked to rank the factors influencing their decision to install robots. Of the respondents, 19 were robot users and 19 were considering adoption.

Survey respondents overwhelmingly ranked efforts to reduce labor cost as their main reason for purchas-



GENERAL ELECTRIC

same year, Andrew Frank's quadruped vehicle, controlled by a small, onboard computer, takes its first steps at the University of Southern California.

1970

Victor Scheinman demonstrates what becomes known as the Stanford arm — a small, electrically powered manipulator — at Stanford University.

1972

The force vector assembly concept, by which a servo-controller can guide the assembly of parts, is developed at the Charles Stark Draper Laboratories.

1973

A computer-integrated robot assembly station, developed at Stanford, puts together ten automobile water pumps in an experiment there.

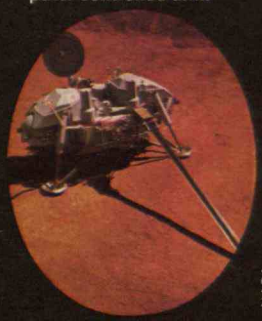
Richard Hohn develops the T³, the first commercially available, minicomputer-controlled robot, for Cincinnati Milacron. ▼



CARNEGIE-MELLON

1974

Following the development of his first Vicarm — a small electrically powered arm — Scheinman founds Vicarm, Inc., and builds a minicomputer-controlled arm.



NASA

1976 ▲

NASA's Viking 1 and 2 landers perform on Mars with their sample-collecting arms.

Vicarm builds the first microprocessor-controlled robot and ships it to the Navy Research Lab.

1976 cont.

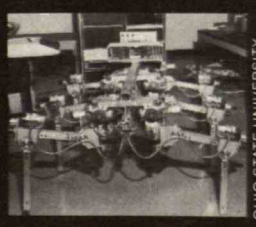
A compliant robot wrist is developed by Draper Labs.

A vision system and a robot programming language (AL) are interfaced by Ralph Bolles at Stanford.

The HARPY speech understanding system is completed by Raj Reddy at Carnegie-Mellon.

1977

A hexapod vehicle, developed by Robert McGhee, walks while tethered to a computer at Ohio State University. A similar machine walks at the Moscow Institute for Mechanics. ▼

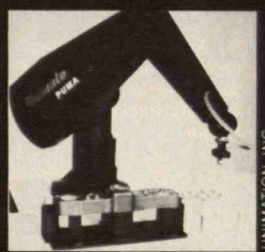


OHIO STATE UNIVERSITY

1977 cont.

ASEA commercializes a microprocessor-controlled, electrically activated robot in two sizes.

A vision module developed at SRI International is marketed by Machine Intelligence Corp.



UNIMATION, INC.

1978 ▲

The first PUMA (programmable universal machine for assembly) prototype, based on Scheinman's M.I.T.-model arm, is shipped to General Motors by Unimation, Inc., which acquired Vicarm the previous year.

The use of robots could greatly boost the efficiency with which machine tools and other capital equipment are produced.

ing robots. A 1980 survey conducted by the Charles Stark Draper Laboratories of Cambridge, Mass. also determined that direct labor cost was the primary motivation for using assembly robots. Users frequently pointed out that the return on their investment in robotics would not be favorable without a resulting dramatic decrease in direct labor costs.

One executive speculated that inexperienced users weigh only direct labor costs because they do not know what other categories of cost will be affected. He said that his firm had learned how to quantify indirect benefits such as improved quality and reduction in materials requirements. But other experienced users did not report this kind of learning, and the benefits of improved product quality and increased flexibility were generally considered "nebulous."

Some respondents indicated that they also take into account broader strategic concerns such as long-term competitiveness, but only one firm said outright that it had invested heavily in robotics to improve the quality and competitive standing of its product. That firm was also the only one to emphasize strongly other "intangibles" such as improved production flexibility, and it was alone in not evaluating robot applications primarily on the basis of conventional return-on-investment calculations.

The firms were asked to estimate what percentage of jobs within a given occupational title could be done by a non-sensor-based robot similar to most of those on the market today ("Level 1" robots), and by the next generation of robots with rudimentary sensing capabilities ("Level 2"). Based on these results, we estimate that Level 1 robots could theoretically replace about 1 million operators, and Level 2 robots could theoretically replace 3 million of a current total of 8 million operators. However, this displacement will take at least 20 years. By 2025, it is conceivable that more-sophisticated robots will replace almost all operators in manufacturing (about 8 percent of today's workforce), as well as a number of routine nonmanufacturing jobs.

The private and public sectors should make a concerted effort to plan for these changes. The transition will not be catastrophic if workers are properly trained and directed toward growth areas. In fact, this transition will probably be less dramatic than the

1979

The first version of ACRONYM, a vision system based on geometric reasoning, is developed at Stanford.

1980

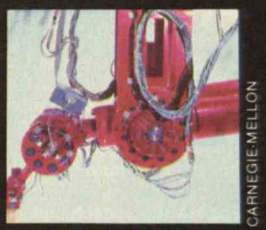
The Robotics Institute (now the largest academic robot lab in the U.S.) opens at Carnegie-Mellon.

The University of Rhode Island demonstrates a robotic system that picks randomly stacked rods out of a bin.



CARNEGIE-MELLON

▲ A mobile robot developed by Hans Moravec at Stanford negotiates a simple obstacle course, taking 15 minutes to move three feet.



CARNEGIE-MELLON

1981 ▲

A direct-drive manipulator, with no mechanical linkages, is developed by Harry Asada and Takeo Kanade at Carnegie-Mellon — enabling the robotic device to move with great accuracy at high speeds.

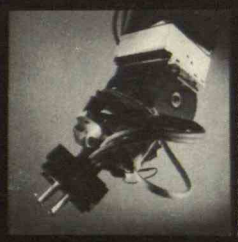
Unimation demonstrates a PUMA mounted on a microprocessor-controlled mobile base.

The Neiman-Marcus Christmas catalog advertises a Unimation-designed "Domestic Robot System" that can open the doors, take out the trash, bring in the paper, sweep the floor, water the plants, dust the furniture, ▲ pick up after the children, and pour the wine. The deluxe model includes a color TV and an AM/FM stereo radio and cassette player. The catalog also describes a robot pet named Wires.

1982 ▶

Donald Seltzer builds a sophisticated force-sensor for the Draper Labs wrist, enabling the robot's microprocessor to calculate the force exerted by the robot hand and manipulate the hand and arm accordingly.

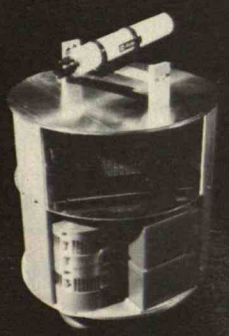


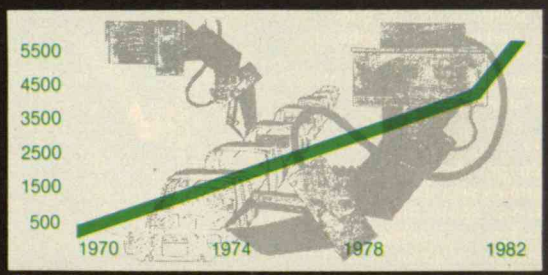


DRAPER LABORATORY

1982 cont. ▶

Now at Carnegie-Mellon, Moravec designs a prototype of the second-generation "Moravec cart," improving its speed tenfold and adding three-dimensional vision.





The U.S. population of industrial robots exceeds 5,500.

impact of office automation. By 2025, most current operators will have retired or left their jobs, and robot manufacturing, programming, and maintenance itself will provide some new jobs, although most will probably not be in manufacturing. Growth sectors in the economy, including undersea and space exploration, may also provide many new jobs. Therefore, young people entering the labor force in the near future will have to learn marketable skills other than welding, machining, and other tasks that are being robotized.

Even though the adjustment problems seem manageable, the potential for social unrest in specific locations cannot be dismissed quite so lightly. Over half of all the unskilled and semiskilled workers in jobs that could be replaced by robots are concentrated in the five major metalworking sectors. Almost one-half of all production workers in these five industries are geographically concentrated in five Great Lakes States—Indiana, Illinois, Michigan, Ohio, and Wisconsin—plus New York and California. The metalworking sector accounts for a large percentage of total manufacturing employment in these states. Therefore, the impacts of not improving the productivity and competitive standing of these industries will be concentrated in the same few states.

There may also be a disproportionate impact on racial minorities and women. Nonwhites account for only 11 percent of the national workforce but comprise between 15 and 20 percent of manufacturing operators and laborers. And women employed in semiskilled and unskilled manufacturing jobs are less likely to be represented by labor organizations than their male counterparts, leaving them more vulnerable to displacement by technological innovation.

Minimizing this displacement through attrition does not seem feasible. According to the Bureau of Labor Statistics data, only 1 to 3 percent of metalworking employees leave their place of work as a result of quitting, discharges, permanent disability, death, retirement, and transfers to other companies. (These figures include only people who actually leave their establishment, not those who change jobs within one company.) The vast majority of manufacturing workers still have 20 or more years of active work life left. As of 1980, between two-thirds and three-fourths of these workers were less than 45 years old, which means that barely a third of the workforce would have retired normally by the year 2000. Although skilled workers are usually older, they are not as likely to be replaced by robots in the near future.

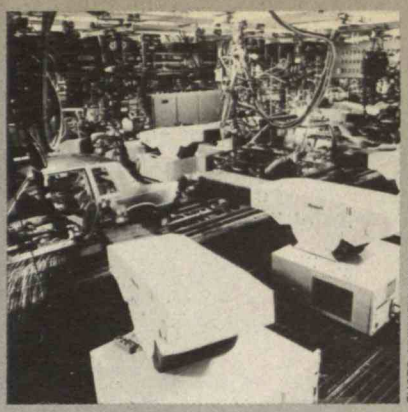


PHOTO: UNIMATION, INC.

The ranking of motivations for using robots by companies currently using them and by those considering using them. Other motivational factors mentioned by the companies included "to give an image of innovativeness" and "to keep us with the Japanese." (*Data: CMU Robotics Survey, April 1981*)

	Users	Prospective users
1	Reduced labor cost	Reduced labor cost
2	Elimination of dangerous jobs	Improved product quality
3	Increased output rate	Elimination of dangerous jobs
4	Improved product quality	Increased output rate
5	Increased product flexibility	Increased product flexibility
6	Reduced materials waste	Reduced materials waste
7	Compliance with OSHA regulations	Compliance with OSHA regulations
8	Reduced labor turnover	Reduced labor turnover
9	Reduced capital cost	Reduced capital cost

Union Response

Labor unions will be heavily involved in the move toward robotics. Over one-third of all wage and salary workers and a significantly higher proportion of production workers (85 percent of motor-vehicle equipment operators, 52 percent of laborers, 47 percent of other durable-goods operators, and 41 percent of nondurable-goods operators) are represented by labor organizations. Over 90 percent of those represented are actual union members.

Unions and employers have devised contract provisions to soften the impact of technological change, as well as to allow workers to share in the benefits from improved productivity. For example, the United Autoworkers Union's "wage-improvement factor" explicitly calls for an annual benefit based on a percentage of increased productivity, independent of cost-of-living considerations.

Companies can spread fewer available jobs among a greater number of employees by giving workers paid time off in addition to legal and religious holidays. The UAW negotiates such paid personal holidays

	United Automobile, Aerospace, and Agricultural Implement Workers of America (UAW)	International Brotherhood of Electrical Workers (IBEW)	International Association of Machinist and Aerospace Workers (IAM)	International Union of Electrical, Radio, and Machine Workers (IUE)
Retraining provisions, cost burden on employer	Retraining for new position is determined by a committee of management and union representatives.		Company is responsible for establishing retraining programs at its own expense and during regular work hours.	Company will make available specialized training for qualified workers displaced as a result of technological changes.
Paid personal holiday (PPH)	Workers become eligible for PPH after one year of seniority and a set number of pay periods per year.			
Relocation allowances	Amount of allowance ranges from $500 to $1760 depending on worker's marital status and transfer distance. Seniority and other benefits unaffected.		Company provides moving arrangements and pays transfer costs; transferred employees carry all rights except seniority to new plant.	
Advance notice	Advance notice of technological change is provided through a National Committee on Technological Progress composed of union and management representatives.	Company retains sole right to manage its business, including the right to introduce technological improvements.	A joint union-management Committee for Technological Change will study effects of technological change on workers and issue recommendations to management.	A joint union-management committee will discuss impact of technological change on workers.
Sharing of increased productivity benefits ("wage improvement factor")	Exclusive of cost-of-living, profits from new technology are shared between management and UAW workers.			
Supplemental unemployment benefits	Aid provided to laid-off auto workers.	Employees receive a retirement service, if eligible, or a termination allowance.		
Severance pay		Employees eligible for severance pay after 5 years of service will retain all union rights.		

The nuts and bolts of contractual clauses relevant to workers displaced by technological change. Paid personal holidays (PPH) are included because this benefit can serve to distribute fewer job responsibilities among more workers. These summaries were compiled from the 1979 collective bargaining agreements between General Motors Corp. and the United Autoworkers, between Columbia Lighting Co. and the International Brotherhood of Electrical Workers Local 73, General Motors and the IUE, and the "model contract" of the International Association of Machinists.

when productivity is increasing within a plant and unit labor requirements are decreasing. Other unions have implemented a similar strategy by increasing standard vacation time. The UAW is also the principal national advocate of providing supplemental benefits in addition to unemployment compensation for workers who are laid off.

"Transitional allowances" can ease the impact on workers transferred from one plant to another. In four union contracts we reviewed, individual allowances range from $500 to $1,760. In some cases other benefits such as seniority also follow transferred employees. Severance pay may also provide the firm with a quick but costly means of reducing the size of its workforce—workers may be paid lump sums to leave their jobs and may also receive a percentage of their pension benefits.

Advance notice to workers of technological change is often a stipulation in negotiated contracts. The UAW and International Association of Machinists require committees composed of both union and management representatives to study technological developments. (However, the current contract of the International Brotherhood of Electrical Workers gives management the sole right to administer the introduction of new technology.)

Retraining provisions have also been negotiated as the responsibility of the employer by three of the four unions we studied. As a result of the recently ratified Ford-UAW Agreement, a joint Union-Management Employee Development and Training Program will be established. This center will arrange for or provide "training, retraining, and development assistance for employees displaced by new technologies, new production techniques, and shifts in customer-product preference. Similar efforts will be undertaken for employees displaced as a result of facility closings or discontinuances of operations." In addition, the UAW has run its own training and retraining programs.



MIT

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(Photo: James J. Snyder, '80)

A Massive New Health Science Facility Is Dedicated to Uncas and Helen Whitaker



PHOTOS: MARGO WOODRUFF

The largest single addition to M.I.T. since the construction of the original main building in Cambridge in 1916 was given a mouthful of names at its dedication on March 5: the Whitaker College of Health Sciences, Technology, and Management and the Medical Department Health Services Center.

The $26 million complex gives the Institute:

☐ A major new facility—155,000 square feet of space—for research and teaching in health science, health-related technology, and management of medical care. Already Whitaker College has a faculty and staff of some 180 professionals, and the total will eventually reach nearly 300, most of whom will have offices and laboratories in the new building.

☐ A coordinated Health Services Center with complete medical care facilities for the M.I.T. community—ambulatory services; medical, dental, surgical, psychiatric, and social work facilities; diagnostic clinics and laboratories; offices for the M.I.T. Health Plan; and an 18-bed hospital-infirmary. Some 275 employees are involved in responding to more than 125,000 visits a year, and for the first time in 20 years the Medical Department has all its facilities for this job in a single, coordinated space.

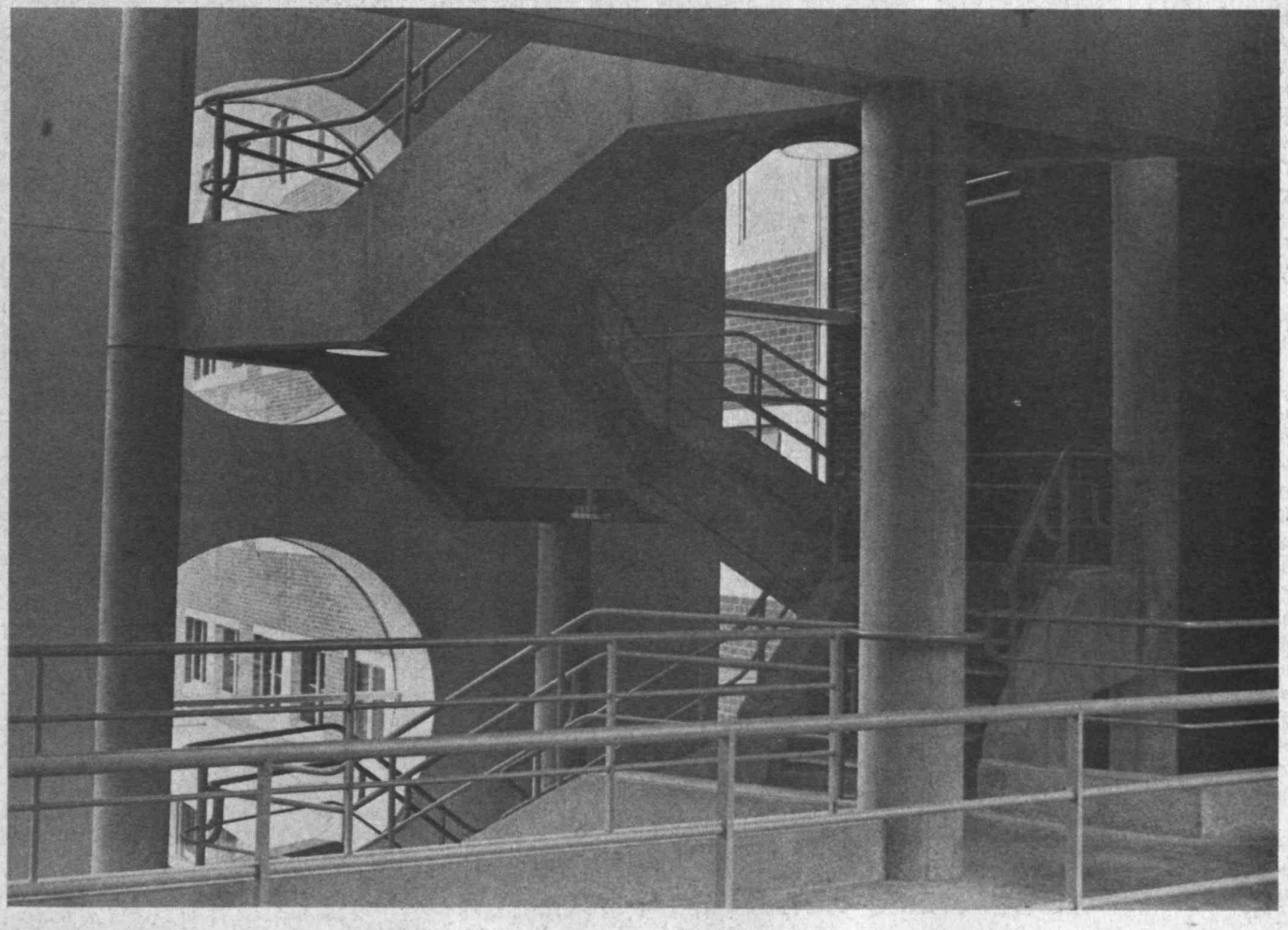
☐ A six-story atrium with picture windows, round windows, a square window, a triangular clerestory, and a network of bridges and stairways. With landscaping and the adjacent arts and media technology building completed (*see* Technology Review *for April, pp. A8-9*), it will provide an impressive east-facing approach to the campus which will surely remind visitors of the elaborate works of hotel architect John Portman.

The complex was dedicated to the late Uncas A. Whitaker, '23, and Helen F. Whitaker, who together began supporting the life sciences at M.I.T. some 15 years ago. Since then, their names have been given to the Whitaker Building (Building 56, occupied by the Departments of Biology and Nutrition and Food Science), to two professorships in biomedical engineering and health sciences, and to a health sciences fund which supports graduate students and faculty research in the health sciences at M.I.T., Harvard, and Boston University. With their gifts to the Whitaker College, Howard W. Johnson, chairman of the Corporation, said at the dedication ceremonies, Mr. and Mrs. Whitaker join the ranks of M.I.T.'s greatest benefactors—George Eastman, Alfred P. Sloan, Jr., '95, Katharine Dexter McCormick, '04 and Cecil ('23) and Ida Green; and "as patrons of the life sciences," said Mr. Johnson, "they stand alone."

Exploiting Science and Technology for Health

At the dedication, Mr. Johnson traced the concept of the Whitaker College, melding the physical and life sciences and engineering to medical science, to a visit in 1966 from Dr. James Shannon, then director of the National Institutes of Health. There was need in the U.S. for "a new kind of physician who can exploit the full power of science and technology," Dr. Shannon told Mr. Johnson and Dr. Jerome B. Wiesner (then president and provost, respectively), and the N.I.H. was ready to provide substantial funding to M.I.T. if the Institute would agree to launch a full-scale medical school to fulfill this need.

"It all looked all right," Mr. Johnson recalled at the dedication, and M.I.T. was "sorely tempted to say 'yes.' " But it didn't happen in the end because M.I.T. lacked the "massive new endowment" which such an enterprise would demand. Instead, the idea of a union between medicine and technology led to the close cooperation between Har-







To Howard W. Johnson (right), chairman of the Corporation, and standing-room-only audience at the dedication of the Whitaker Building, Helen F. Whitaker (left) expressed her "deep sense of satisfaction" in the completion of the building and her "great expectations" of the activities which it houses. (Photos: Calvin Campbell)

vard Medical School and M.I.T. which was formalized in the Harvard-M.I.T. Division of Health Sciences and Technology. Now that program, too, takes it place in the Whitaker College.

So do many others, and completion of the massive new Whitaker complex gives great and sudden visibility to the extent of health-related research at M.I.T. The work has been growing steadily for more than 20 years until now that field accounts for one-third of all research at the Institute, President Paul E. Gray, '54, said at the dedication ceremony. President Gray expects the new Whitaker College building to be "the gateway for people from every corner of the Institute to contribute to medical science and health care," and in that role it will make visible the health sciences as a major extension of M.I.T.'s original thrust in engineering and the physical sciences. At the time of the dedication, fully half of the Whitaker College's space was unoccupied—carpeted offices, parquet corridors, and pristine laboratories finished in white and various shades of warm grey, lilac, and violet awaiting their first tenants.

Renewing the Role of Private Philanthropy

In addition to the Whitakers, major contributors to the new complex were the Pew Memorial Trust of Philadelphia, the Kresge Foundation, the Whitaker Foundation, Amp, Inc., the Schering-Plough Foundation, and the Max C. Fleischmann Foundation. Indeed, the $9 million given by the Pew Memorial Trust is "one of the largest foundation grants since the founding of the Institute," according to Mr. Johnson; and the whole project renews his faith, he said at the dedication, in "the role of private philanthropy in seeking out those centers of excellence which can make important contributions to human welfare."

Architectural plans for the complex were a joint venture of Gruzen Partners—Mitchell Giurgola, with Gruzen's participation chiefly the work of two M.I.T. classmates, Jordan L. Gruzen, B.Arch.'57, and Peter A. Samton, B.Arch.'57. Turner Construction Co. was the general contractor.

Whitaker, Not Whitehead

Don't confuse the Whitaker College (*see above*) with the Whitehead Institute, the nonprofit independent biomedical research center to be built in Cambridge by philanthropist Edwin C. Whitehead. Whitaker College is part of M.I.T., devoted equally to education and research, fully funded by the Institute, and responsible to its administration. In contrast, the Whitehead Institute is to be governed by its own directors and administration and will have close but specified ties to M.I.T.

At the time of the Whitaker College dedication, the Whitehead Institute, whose relationship with M.I.T. was approved by the M.I.T. Corporation in March, was negotiating with the city of Cambridge to build its laboratory on city-owned land in the Kendall Square redevelopment area.

Kennedy: Whitaker's Three Challenges and Unique Opportunity

The Whitaker College is positioned for a key role in three national problems which transcend its great opportunities to contribute to health care and its management, Dr. Donald Kennedy, president of Stanford University, said at a dinner on March 4 preceding the dedication of the new M.I.T. health sciences complex.

Indeed, Dr. Kennedy said, Whitaker's first problems will be institutional ones:

☐ The fact that bioengineering research is now a field for aggressive entrepreneurship means that there will be strong pressure toward industrialization and secrecy. The college must lead in finding ways to keep what Dr. Kennedy called "the proprietary impulse toward exclusivity and secrecy" from "intruding on academic values."

☐ The government, too, is pressing for secrecy. "The current effort to extend the blanket of arms export regulations from military devices and process technology to cover fundamental research—where neither the courts nor wide public policy would hold it belongs—is a serious threat," Dr. Kennedy declared, to which the Whitaker College's response can be important.

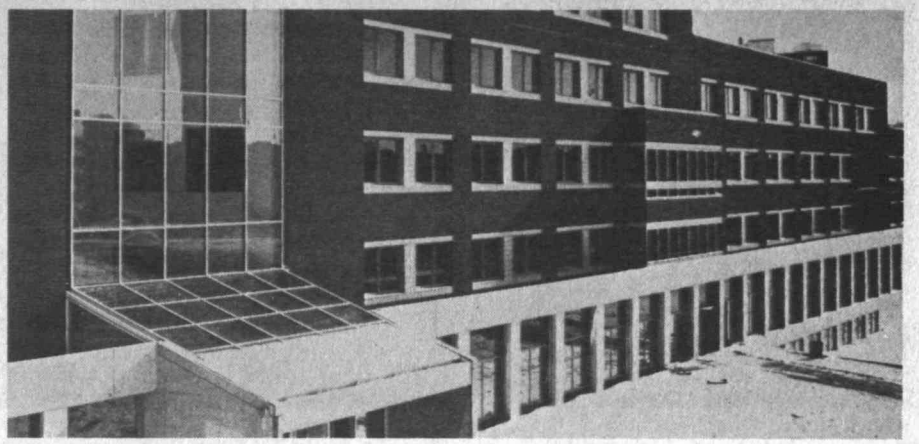
☐ Effective interdisciplinary ventures, especially in fields so disparate as health care and management, are a difficult administrative challenge. The problem, said Dr. Kennedy, is that people from disparate fields retain allegiances to different academic traditions, and they often don't understand each other. So there are "almost irresistable temptations to build enclaves instead of collaborations" when such people are thrown together.

But, having cited these problems, Dr. Kennedy was reassuring to his audience including many members of the M.I.T. Corporation assembled for their traditional March meeting as well as for the Whitaker ceremonies.

The timing of the new enterprise is ideal, he said. The commercial success of biotechnology has added one more arena to those which have motivated the clinical, pharmaceutical, and medical device industries to aggressive innovation during the past decade, said Dr. Kennedy, and health care is now "an enterprise of extraordinary vigor."

Furthermore, Dr. Kennedy told his M.I.T. audience, the richness of the Institute's environment is unique—"an extraordinary range of talent in the sciences and engineering," said Dr. Kennedy. "If you turn even a small part of the awesome intellectual capacity of this place into a new channel of concern for the problems of health—then, my friends," said Dr. Kennedy, "you really will have done something terrific."

The Medical Department's Health Services Center occupies the south wing of the new Whitaker building—95,000 square feet where the Medical Department "puts it all together again," in the words of its director Dr. Melvin H. Rodman. Included: around-the-clock medical care, clinical and diagnostic facilities, pediatric section, psychiatric and social work programs, health education service, and 18-bed inpatient infirmary. Photo: Ivan Massar



Health Care Management: Can We Change the Slope of Health Care Costs?

Medicine is different from all the other enterprises to which technology is applied, and the role of technology in hospitals and clinics is different, too. For both these reasons, new technology has more to do with increasing than decreasing the cost of health care. The real culprits are you and me as patients—our uncompromising demand for better health and longer life—the doctors who treat us, and the diffused health care system to which we are all committed, like it or not.

The incentives are wrong: they tend to press costs upward, not downward. What's needed, said Professor Alain C. Enthoven of Stanford, is the cost-cutting incentive of competition. But how do you pit doctors against doctors and hospital against hospital without jeopardizing the quality of their care?

. . . All in all, some very chilly water in which a new enterprise in the management of medical care must swim. But Professor Edward B. Roberts, '57, who is responsible for a new program in health care policy and management in the Whitaker College (*see p. A3*), takes it all as a reassuring challenge: "plenty of agenda" for the future, he told a panel during dedication ceremonies for the Whitaker College building. His prescription is a three-pronged research effort:

☐ Study the environmental and social determinants of good health in the U.S., in the hope that "we can optimize these positive factors and so relieve pressure on health care facilities."

☐ Assess the institutional relationships in health care, seeking changes so that doctors and hospitals have stronger incentives to reduce costs and improve prevention.

☐ Evaluate the social and economic consequences of new medical technologies to understand the effect they have on total health care costs.

The High Cost of Dying

Can such well-intentioned research really make a difference?

Whitaker College dedication panelists left their audience with a sense of unease: perhaps medical care costs have a life of their own, nurtured by man's deepest instincts for helping himself—which turn out to be synonymous in this case with his instincts of general humanitarianism.

Hospital costs are the fastest-rising segment of total health care costs. And most hospital costs are accumulated in caring for a very few very sick patients, many of whom are in fact in the last years of their lives, according to Dr. Frederick C. Robbins, president of the National Academy of Sciences' Institute of Medicine, speaking at the formal Whitaker College dedication. From the day they enter medical school, doctors are taught to do everything possible for every patient, including these; and the patients themselves, too, are conditioned to expect the very best—including the most expensive new technology. "There is simply no evidence that we are willing to forego the technological imperatives," Dr. Richard J. Greene, director of the Veterans Administration Medical Research Service, told the symposium.

Under these conditions, complained Dr. E. David Nordberg from the audience, you cannot expect the system—or any of its participants—to set limits; there are simply no incentives to do so. "Who shall get how much care, whose longevity will be increased?" asked Dr. Nordberg rhetorically. "As long as those questions go unanswered," he told the symposium, health care will simply continue to be more and more expensive.

Professor Roberts and other panelists retorted by asking Dr. Nordberg and his practitioner-colleagues to share some of the blame. Medical fees are high and in some cases bear too little relationship to cost, said Professor Paul Starr of Harvard's Department of Sociology. Medical schools themselves are somewhat to blame, thinks Dr. Greene: they fail to train physicians in economics and make too little reference to the cost of medical technology. Professor Roberts carried his colleagues one step further: "There are no 'guts' in the profession," he said, "for studying its fee structure."

These problems are exacerbated by a political one: health care is so diffused through the system that cost is never related to a single patient's benefits; no one person or even agency really pays the bills. Insurors, patients, and governments have no common basis for action, said Professor Harvey M. Sapolsky of the M.I.T. Political Science Department.

But Professor Sapolsky and Dr. Robbins both saw signs of hope. Dr. Robbins is encouraged because doctors are now growing interested in the problem of health care costs, starting to weigh the value of some procedures against their cost. Professor Sapolsky notes that some private hospitals, and a few public ones, are now making money—quite a lot of it, he pointed out. They're doing it by accepting only wealthy, well-insured patients who can pay the cost of the treatment they need, and by eliminating such expensive add-ons as research and teaching. As these institutions proliferate, the non-profit, public service institutions will have rapidly increasing responsiblities. That inequity will turn out to be very large, a burden which may well be strong enough "to stimulate the basic changes which have thus far eluded us," Professor Sapolsky said.

Dr. Enthoven did not mean to suggest that health care should be returned to the free market; rather he proposed market conditions that favor cost-effective care—a situation, for example, in which consumers are allowed to choose their health care finance systems and are rewarded for selecting an economical plan. Will this jeopardize health care? No, he says: physicians would provide high quality care because it would be in their competitive interest to do so.—*J.M., B.G.*



Jeff Mogul, courtesy Technique

Federal Student Aid Cuts Hint at a Coming Admissions Crisis

M.I.T.'s traditional "aid-blind" admissions policy and its promise to meet the need of any qualified undergraduate student, whatever his or her financial resources, are suddenly in jeopardy.

Substantial cuts in federal student aid funds recommended by the Reagan administration for FY 1983 and the likelihood that further reductions will be requested in the future pose a grave threat to undergraduate and graduate students alike. Indeed, as M.I.T.'s tuition and fees went up by just over 15 percent this spring (*see right*), a heavy cloud of uncertainty hung over admission and student aid policies in the years after 1983-84.

"Intolerable Burden" . . . "Cruel Hoax"

The most serious immediate threat is to graduate students who depend on low-interest loans under the federal Guaranteed Student Loan program. Such students can borrow up to $5,000 a year, with payment of principal and interest deferred until graduation and interest limited to 9 percent. The Reagan administration's proposal is to make graduate students ineligible for GSLs beginning next fall; instead, they would be asked to borrow under a program which requires 14 percent interest and repayment beginning within 60 days of the date of the loan. President Paul E. Gray, '54, believes graduate students would find that an "intolerable burden," and Leonard V. Gallagher, '54, director of student financial aid, says the proposal has elements of a "cruel hoax," since most graduate students would probably be unable to find commercial lenders willing to make loans with in-school repayment obligations.

Significant cuts in federal programs affecting undergraduate scholarships and loans, effective in September 1983, are also included in the Reagan administration's FY 1983 package. For example, the so-called Pell grants to help students from low- and middle-income families are proposed to drop by nearly 50 percent. But the scope and impact of these changes on M.I.T. are not yet clear, says Mr. Gallagher.

As far as next fall is concerned, M.I.T. is pledged, according to Mr. Gallagher, to maintain student aid programs by drawing on general Institute funds. But without substantially increased scholarship and loan resources, federal cuts could soon force M.I.T. to make an applicant's financial resources part of the admissions decision—or to give up its policy of supporting through scholarships, loans, and work opportunities all admitted students who choose to come. President Gray told *The Tech* that "if federal trends continue, we will have to find some way of limiting the calls on general funds for scholarship support." And Peter H. Richardson, '44, director of admissions, says his office faces "a scary time. . . . I feel like the gal tied to the railroad tracks," he told Stuart Gitlow, '84, of *The Tech.*

The Voice of the Student

M.I.T. has joined many other colleges and universities in expressing concern for both short- and long-term effects of such sharp reductions in federal student aid programs, and there have been signs of sympathy on Capitol Hill. Returning from a day of "lobbying" in Washington, President Gray told seniors attending an Alumni Association dinner at the President's House, "It appears that the Congress is not inclined to let the budget proposals" be enacted without change.

Joseph Minato, '84, one of five M.I.T. students who made a Washington trip in February, reported to Tony Zamparutti, '84, of *The Tech* that "even the most conservative forces in Congress think Reagan's cuts were unreasonable."

But Lane Wilson, '82, found Utah Senator Orin Hatch's legislative aide less encouraging. He was "very interested," Mr. Wilson reported, but he said the Senator "wanted to stay in line with Reagan's policies."

Costs Go Up Another Notch, to $13,500

For the 1982-83 academic year beginning July 1, charges for tuition, room, and board at M.I.T. will increase 15.8 percent, bringing the "typical student budget" to $13,500 for the year.

Tuition next year will be $8,700, up 17.4 percent from this year's tuition of $7,400. Typical room and board charges will go to $3,550, up 11.6 percent from this year's $3,180.

A typical student budget includes allowances for books, materials and personal expenses: for this year that figure is $11,700. The next figure of $13,500 will put M.I.T. slightly ahead of Harvard, at $13,285.

More than half of M.I.T.'s undergraduate students receive financial aid in the form of grants, educational loans and term-time employment. The amount of need is determined by deducting from the student budget the amount a student's family can be expected to contribute, based on income and resources. The student then is expected to meet a "self-help" level through loans and term-time employment; M.I.T. then meets student need above the self-help level with grants. The self-help level for students receiving financial aid next year will be $4,000, up from this year's $3,400—an increase dictated in part by expected cuts in federal student aid support (*see left*).

President Paul E. Gray, '54, said he realized "how painful these increases are to our students and to their families." But annual increases in tuition in excess of the rate of inflation are necessary "to help us close the gap between our revenues and the rising costs of education," he said. The university's income from its endowments and gifts and grants have not kept pace with inflation. President Gray noted that "we constantly strive to secure new unrestricted support for student aid from outside sources," and he pledged that "during this time of uncertainty about federal aid prospects we intend to do whatever we can so that no student is forced out of school."

Writing Is Added as a Requirement; But Who Knows Who Can Write and Who Can't?

All M.I.T. undergraduates in the classes of 1987 and after will have to demonstrate "basic expository writing competence" in "the sort of writing that should be expected of any educated person" before they can receive bachelor's degrees.

Though that much was certain by mid-March, it was also clear that the facultywas far less at home in setting graduation requirements for qualitative skills such as writing than for such conventional targets as physics, mathematics, and chemistry—and even athletics. As a result many questions of how to test for writing skills and how the writing requirement should relate to other academic demands of the General Institute Requirements remained under debate as the year neared its end.

For at least 50 years there has been no specific test in writing or composition for any M.I.T. undergraduate. Courses in writing have been a popular option, along with those in history, anthropology, literature, music, language, economics, and politics, for fulfilling the humanities requirements, and all faculty members were supposed to criticize not only what their students said but how they said it in exams and term papers.

But everyone's goal is no one's responsibility, and early this year the Committee on Educational Policy told the faculty that "a substantial number of M.I.T. students do not achieve a level of writing proficiency adequate for either their course work or their professional careers." Perhaps half of M.I.T. undergraduates have a "writing problem of some kind," said Professor Felix M.H. Villars, chairman of the faculty, and 10 percent have "a problem serious enough to present a constraint in their professional progress."

"There is widespread agreement among faculty and students," the CEP said, "that there should be a writing requirement."

President Paul E. Gray, '54, is on record as an enthusiastic advocate. Earlier this year he told a group of freshmen, "I know of no one who has been a success in any field of endeavor without being able to present views on a subject that are clear, concise, and persuasive to others."

The CEP's proposals were for a two-stage requirement. Students who did not do well in a College Board test in English before entering the Institute would be required to pass a writing test or take a writing subject, normally during the freshman year. Later, every undergraduate would have to submit for grading as to writing quality some work performed in his major field.

Does It Go Far Enough—Or Too Far?

The faculty's questions were wide-ranging.

Were there, in fact, enough good writers on the faculty to fairly judge the students? Yes, said one member; the goal as set forth represents only adequacy, not really proficiency. Indeed, we all must have a measure of humility: few of us can claim mastery of this skill.

One member of the faculty agreed with Professor Villars that most of the faculty knows good writing from bad—but he fears they would not agree on which is which.

Was the plan as set forth good enough, the requirement high enough to make any difference? While speaking in favor of it, Professor Peter H. Smith, head of the Department of Humanities, warned that the requirement "needs to be stringent to be effective. . . . We support it as far as it goes," he said, "but some of us are not sure it goes far enough."

Then came a warning from the provost, whose office is suggested by the CEP to have day-to-day responsibility for operating and monitoring the new writing requirement. The faculty will have to commit a good deal of time to advocating and weighing good writing, said Professor Francis E. Low, and budgetary constraints mean that those tasks will have to be done "by people who are already here," he said. A more stringent requirement, such as implied by Professor Smith's comment, "might turn out to have a price tag we can't afford."

Meanwhile, *The Tech*'s editors fear even the CEP's recommendation may go too far. Before they ask students to take more courses and pass more tests, said *The Tech*, let the faculty remember President Paul E. Gray's admonition in his inagurural on the pressures and pace of an M.I.T. undergraduate education. Any call for new standards of writing proficiency, said *The Tech*, "must be accompanied by a wide-eyed concern for the already-high-pressure environment" of undergraduate education.

Why pick on writing? asked another faculty member during the debate. Technological advances may soon make writing an obsolete form of communication, and a public speaking requirement might be far more relevant.

But these questions fell before the weight of the CEP recommendation, and after voting a writing requirement, the faculty handed over to a committee the sticky questions of implementation. The committee's assignment during the coming summer will be to study the available tests of writing skills, develop an in-house M.I.T. test if needed, and survey the kinds of help which students will need to fulfill both aspects of the new target.

Meanwhile, as a pilot for what might lie ahead, the office of the provost and the Writing Program joined hands early this spring to organize a Writing Center—"personalized aid for students who have writing problems that cannot be remedied in a writing course."

Its director, Steven Strang, calls it a "drop-in center—a place that any student can come to and get help on any kind of writing problem, from basic punctuation to style." He warned students who came with a rejected term-paper problem that the Center wouldn't make the corrections. "We see what the problem is and work on it—in general," said Mr. Strang.

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"Old Hands" to the Newcomers: Let Careers "Hang Loose"

Advice from 21 alumni to 150 freshmen on how to choose careers: in two words, hang loose.

Don't expect M.I.T. to make the choice for you—and don't even expect to make the choice while you're here, said President Paul E. Gray, '54, keynote speaker at the Alumni Association's "Trailblazing" program on February 6. Indeed, he said, the Institute's job is to prepare its students for a future "we ourselves cannot understand."

Dr. Gray's advice: don't let your education impose a career choice on you. "The process of trying to relate your interests and abilities to what you do is a process that continues throughout your life," Dr. Gray said. His advice, at every decision point: "make decisions which will expand, not limit, your opportunities. Try to decide what will give you the greatest pleasure. Then," he said, "you'll end up doing what you do best."

Many of the alumni who volunteered as seminar leaders for "Trailblazing" had themselves made career changes. Thomas Fraser, Ph.D.'75, vice-president of Repligen Corp., simply assumed when he started out that every molecular biologist wound up in the academic field. Now he's setting up a corporate laboratory—an opportunity which he hadn't expected to have as little as two years ago.

Dr. Jerry M. Greene, '71, made his first career change while at M.I.T,. and has made two more since then: he entered the Institute expecting to study architecture but ended up with a degree in biology; then he went to medical school and now he's in research—a fellowship on arthritic diseases.

The venture capitalists among the alumni seemed to lead the most varied lives—and to take the most aggressive attitude toward career change. Gordon B. Baty, '61, who's now president of Wormser Engineering, Inc., working in the field of combustion, has already been at the helm of two other companies—one in numerical control and another in optical character recognition. Dr. Baty concludes that he isn't comfortable when wedded to any one field too long; "after a while I get bored and want to move on."

Nothing wrong with that, said Michael J. Greata, vice-president of Apollo Computer, Inc.: "Things only get done by people who believe they can be done."

For most of the freshmen, that approach seemed a little aggressive; Bernard Kupferschmid's advice sounded better: "You need a mentor," he said—"or better yet two or three mentors, so you have one left when one moves on." Lean on their advice, said Mr. Kupferschmid (he's managing director of Technology Transfer International, Inc., and holds a master's degree from the Sloan School), but don't *use* them . . . "because in addition to mentors you need allies."

New Records in the Alumni Fund With Lots of Help from Our Friends

In two weeks of telephoning from the M.I.T. Alumni Center in February, 559 students reached 7,449 alumni who pledged $111,021.55 in gifts for the 1982 Alumni Fund. The same kind of generosity has been greeting Alumni Fund workers throughout the first half of the 1982 fund effort, says Joseph S. Collins, director of the Alumni Fund. The result is a record-breaking mid-year report: $4.5 million from 14,255 donors. The number of donors is 10 percent and the total of giving 12 percent ahead of last year, Mr. Collins said.

The students calling from the Bush Room consumed 1,944 slices of pizza, 32 pounds of potato chips, 36 pounds of pretzels, and 320 liters of soda. They learned first-hand the importance of giving to M.I.T.—and it will surely be harder for them to turn down a bid from the Alumni Fund in the years ahead. But it wasn't exactly a bed of roses. Given the lives M.I.T. alumni lead, students sometimes had to make five or six calls before reaching their targets.

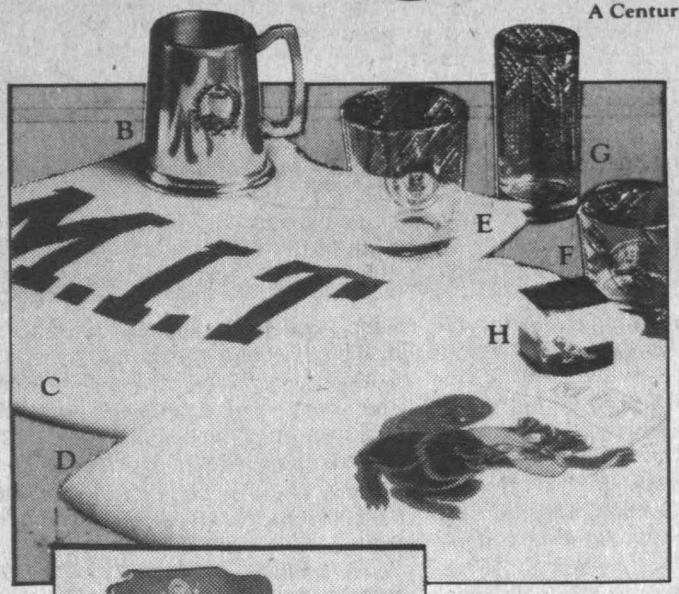
But there were rewarding moments, too, for many of the alumni to whom the students talked were persuaded to make their first gifts ever to the Alumni Fund, and many more of the 3,659 pledges were to renew giving records which had lapsed for several years.

Living at Wellesley

"Meeting and talking to women in their natural environment" is one reason given by an M.I.T. student for living at Wellesley this spring—the first dormitory exchange experiment between the two schools. Starting in February, 10 M.I.T. students have been living in the country and 10 Wellesley students at M.I.T., and Robert A. Sherwood, associate dean for student affairs, thinks there may be as many as 25 to 30 students exchanging places by next fall, when "things will go much more smoothly."

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Fulfilling Automotive Fantasies Nourished at the Sloan School

The Cumberford Martinique is a $125,000 fulfillment of James T. Cumberford's lifetime dreams. "I wanted to do this ever since I was knee-high to a grasshopper," he says—a fantasy which was first given reality when he helped plot the course of venture capital investments in a luxury automobile company as a class project while he was a Sloan Fellow in 1972-73. The Cumberford Corp., of which he is president and his brother Robert is design director, intends to make as many as 70 this year.

James Cumberford, S.M.'73, has been a "car-nut" ever since he can remember.

As a Sloan Fellow in 1972-73—he was then with Cummins Engine Co., Inc.—Mr. Cumberford did a little high-powered fantasizing: he joined some Sloan School graduate students in a class on new venture management taught by Richard S. Morse, '33, to plot the founding and growth of a quality automaker. Less than a decade later he's bringing that fantasy to life with a vehicle described in *Car and Driver* as "a liquid blending of line, color, and texture that hasn't been seen on the road since . . . the late 1930s."

The car is the Cumberford Martinique, a two-passenger convertible—price $125,000. "To say that its looks are spectacular is to say that Catherine Deneuve looks like a woman," wrote *Car and Driver*'s critic David E. Davis, Jr.

But there's more to the Martinique than its looks, for the design represents a unique compilation of automotive technology which is credited to James Cumberford's brother, Robert: running gear from Citroen, engine from BMW, a cast aluminum chassis assembled with American aerospace fasteners, an all-aluminum body, and spectacular, flowing fenders formed of plastic laminate surfaced with mahogany.

The $3-million Cumberford Corp. of Stamford, Conn.—James is president, Robert vice-president and design director—hopes to build 70 Martiniques this year for collectors and aficionados who want something better than the competition—Excaliber, DeLorean, Maserati, and Rolls Royce. After that will come other "highly individual models"—and, says the Cumberford prospectus, "the company is prepared to design, develop, certify, and manufacture special models for other automobile makers" which will combine mass-produced mechanical elements with precision handcrafting.

Katherine Graham for Commencement

The move back toward tradition—a guest speaker for Commencement—stymied last year because its advocates were too late, has borne fruit for 1982: Katherine Graham, chairman and chief executive officer of The Washington Post Co., will speak June 1. It will be the first time since 1964 that the president of M.I.T. has not made the major address.

Mrs. Graham began work at the *Washington Post* as a reporter in 1939 following a year on the staff of the *San Francisco News*; she's been chairman of the board at the Post Co. since 1973. A major figure in U.S. newspaper publishing and communications, she is president of the American Newspaper Publishers Association. The speaker was chosen from suggestions submitted by students, and President Paul E. Gray, who is now relieved of the speech-making assignment, is delighted—"a super choice," he told Barry S. Surman, '84, of *The Tech*.

Advisers and Scholars

Major new assignments and honors have come to several members of the M.I.T. community:

☐ Walter A. Rosenblith, Institute Professor who served as provost from 1971 to 1981, has been named foreign secretary of the National Academy of Sciences. It's an important post, relating to the Academy's responsbilities for international scientific exchange.

☐ Andrew J. Bernoff, '82, whose major is mathematics, was awarded a British Government Marshall Scholarship for two years of study at Cambridge University. Mr. Bernoff entered M.I.T. from Dresher, Pa., and he'll study fluid dynamics at Cambridge—"one of the best places in the world" in that field.

☐ Frank Conroy, visiting lecturer in writing in the Department of Humanities, is now director of the literature program of the National Endowment for the Arts. He's continuing his teaching in fiction and short-story writing at M.I.T., commuting between Boston and Washington.

☐ Four members of the M.I.T. community are now members of the White House Science Council, an advisory group to George A. Keyworth, White House science advisor. Solomon J. Buchsbaum, Ph.D.'57, executive vice-president of Bell Telephone Laboratories, is council chairman, and its members include Edward E. David, Sc.D., '50, president of Exxon Research and Engineering Co., Paul E. Gray, '54, president of M.I.T., and Arthur K. Kerman, Ph.D.'53, director of the Center for Theoretical Physics at M.I.T.

Sexual Equality in the Royal Family

Should M.I.T. have:

☐ A Homecoming queen, gender unspecified, chosen by popular election?

☐ A Homecoming queen (female) and king (male), chosen by popular election?

☐ A celebration at Homecoming led by the ugliest-man-on-campus (UMOC), whose choice is a charity fund-raising project of Alpha Phi Omega service fraternity?

☐ No king, no queen?

Distressed feminists and school-spirit advocates had clashed on the issue last fall, and to resolve it for all-time a binding referendum giving those four choices was on the annual student government election ballot in March. The safe way turned out to be the winning way, by a margin of over 200 in 1,883 votes cast: there will be a queen *and* a king for next fall's Homecoming festivities.

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Meetings and Conferences

The following are among major meetings now scheduled at M.I.T. and by M.I.T. related groups during the balance of this year (for information: Joseph J. Martori, associate secretary of the Alumni Association, Room 10-115M). In addition, a group of 50 short courses on timely topics in technology will be offered at the Institute during the 1982 Summer Session, and five programs in transportation technology and planning will be offered in July and August by the M.I.T. Center for Transportation Studies (for information: Office of the Summer Session, Room E19-356; and Center for Transportation Studies, Room 1-123).

May 4 (Cambridge)
Symposium on lasers in spectroscopy and technology*
May 20 (Cambridge)
Symposium on electronic materials and devices*
May 26 (Cambridge)
Symposium on corporate office automation*
June, July, and August (Cambridge)
Short courses in advanced microcomputer concepts and applications
June 10-13 (Cambridge)
"Tech Night at the Pops" (June 10), Technology Day (June 11) and alumni reunions
June 14-17, (Cambridge)
Power Electronics Specialist Conference
June 17-20, (Cambridge)
Annual conference of the American Humanist Association
June 21-22 (Cambridge)
Conference on facilities management for senior executives
June 21-25, (Cambridge)
Conference on advances in finite element methods in structural mechanics
June 24-27, (Cambridge)
First National Conference on Black Administrators at White Campuses
(sponsored by the Association of Black Administrators at M.I.T.)
August 2-5, (Cambridge)
Third International Conference on the Behavior of Onshore Structures
August 18-22 (Cambridge)
Research conference of the International Federation of Organic Agriculture Movements
September 24-25, (San Francisco)
M.I.T. Alumni Officers Conference (West)
October 2-3, (Cambridge)
Centennial celebration of the Department of Electrical Engineering and Computer Science
October 5-7 (Amman, Jordan)
Conference on regionalism and international air transportation
October 8-9, (Philadelphia)
M.I.T. Alumni Officers Conference (East)
October 14-15 (Cambridge)
Second national remanufacturing conference

***Attendance limited to representatives of companies in the M.I.T. Industrial Liaison Program.**



Alex W. Dreyfoss, '54 (right) who was host at a luncheon for M.I.T. Sustaining Fellows in Palm Beach, Fla., on February 16, introduces president Paul E. Gray, '54 (left), the guest of honor. (Photo: Davidoff Studios, Palm Beach)

Nationwide Series of Sustaining Fellows Events to Introduce the New President

☐ The dinner on October 30, 1981, at M.I.T. at which Vice-President George Bush was guest of honor (*see Technology Review for February/March, p. A16*) was the highlight of a busy year for the M.I.T. Sustaining Fellows, donors whose annual unrestricted gifts to M.I.T. are $2,000 or more or whose cumulative unrestricted giving is $20,000 or more. Indeed, during the past two years a series of 10 events have been staged across the country to introduce Paul E. Gray, '54, as the Institute's new president.

The gatherings in late 1980 included a luncheon in Dallas on October 6, hosted by Edward O. Vetter, '42, and a luncheon in Los Angeles on November 17, hosted by DuWayne J. Peterson, Jr., '55. In 1981 the series continued with luncheons in New York on March 19 and April 22, the first hosted by S. James Spitz, Jr., '43, and the second co-hosted by Carl M. Mueller, '41, and Thomas F. Creamer, '40; a luncheon in Stamford, Conn., on April 20, hosted by Dayton H. Clewell, '33; a luncheon in Cleveland on May 4, hosted by Joseph F. Keithley, '37; and a reception in Chicago on November 23, hosted by Karl Van Tassel, '25. The final two events of this series with Dr. Gray were held at the beginning of 1982: a luncheon in San Francisco on January 21, co-hosted by Paul M. Cook, '47, George M. Keller, '48, and Denman K. McNear, '48, and a luncheon in Palm Beach, Fla., on February 16, hosted by Alex W. Dreyfoos, '54.

Classes

08

Harold Osborne writes from Pompano Beach, Fla., to say that he has no news from classmates. "Perhaps I should assume in this case that no news is good news," he says.

"Mrs. Osborne and I are both in good health considering our ages. We hope you all are. We are very pleased to be in southern Florida, escaping the bitter cold of the North."—*ed.* (**Harold S. Osborne**, Secretary, Penacook Rd., Contoocook, NH 03229)

10

I have to report the passing of our classmate, **Lewis S. Southwick**, on December 18, 1981. He lived at Shelter Island Heights, Long Island, NY, 11965, and is survived by a stepson, Brigts Dalvell, who resides at 515 Madison Ave., New York, 10022.

Professor **John B. Babcock**, who was elected class secretary at our 65th Reunion, now resides in a nursing home in Portland, Maine. He is physically well and is quite contented. I am sorry to say, however, that he remembers little of his former activities.

I would like to include in these notes any activities (or lack of them) of our classmates. Please drop me a few lines about yourself. We'd like to hear about you.—**Fred. R. Lufkin**, Acting Secretary, 24 Linden St., Portland, ME 04103

13

The response to my December letter was gratifying. We quote from **Cedric Burgher**: "Thank you for keeping up with the Class of 1913 of M.I.T. My activities are minimal.I have four children—two boys and two girls, 14 grandchildren, and two great-grandchildren. I have decided to leave the world to younger hands. It is to be hoped we have some with clear and practical minds." . . . **David Stern** says his activities are limited, as he is recovering from a broken hip. He has two children, four grandchildren, and seven great-grandchildren. . . . **Warren Glancy** writes that he has one daughter, Jean, five grandchildren and two great-grandchildren. He states, "Some other members of '13 could get their names in alumni news if they attended Technology Day." . . . . Jerry (Mrs. **Robert S.) Gans** wrote for her husband, "Pat a snowflake for me. It's 82 degrees today on January 6, 1982 in Fort Lauderdale." Do you think she misses seeing some snow?

Frederick W. Lane writes, "I am happy to be able to carry on some of my lifetime activities. I'm up and around every day and manage my own business affairs. I handle all problems relating to the home in which Mrs. Lane and I have dwelt for 40-odd years. I don't drive now; I use taxis. Reading the newspapers and occasional Chemical Engineering Reports from M.I.T., plus the American Chemical Society News Edition takes up some of my time. My children include one son, a computer engineer, and a grandson and granddaughter now in high school. I give up in stating my opinion of the world today. At times it looks like a mess. Hope I'm wrong. However, I think the U.S. is doing fairly well, and I'm glad to be a U.S. citizen."

We have two deaths to report. **Herbert B. Wood** died on January 9, 1981 and **Howard S. Currier** on December 2, 1981. No further details. If anyone has more information, we would be glad to include in future notes.—**Rosalind R. Capen**, Assistant Secretary/Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

15

Azel Mack, 1915's dedicated class secretary for many years, passed away January 13, 1982. He had lived several years with his friend, Jack Seaverns, in Wellesley, Mass., after giving up residence at 110 Memorial Dr., near M.I.T. After graduation, Azel served on the chemical engineering department staff from 1916-17. He had a very wide acquaintance both among our class members and the chemistry field industry, becoming vice-president of his firm, Dexter Chemical Corp. His efforts ensured the success of our many class reunions which, until lately, were well attended.Aside from becoming class secretary in 1926, Azel was very active in other M.I.T. alumni affairs—reunion chairman (1949-50) and co-chairman (1960). A life member of the Alumni Council, he received the Bronze Beaver award in 1969 in honor of his many efforts. He will be much missed by his classmates and all who know him.

By mistake, the death of **William R. Holway** was reported under the Class of 1912. A native of Sandwich, Mass., he graduated with Class of 1915. Early employment in the field of water supply included that at Providence, R.I., and Alliance, Ohio. By 1922 he organized his own firm which undertook both national and international projects. One of these dealt with a Cuban hydroelectric plant, another recommended changes for Moscow's water supply. Settling in Oklahoma, he designed the fine water supply system in Tulsa derived from the Ozark Mountains watershed. Later he planned the Kerr Dam (Lake Hudson) and the associated Salina pumped storage project. He was an honorary member of the American Society of Civil Engineers, a member of the American Society of Mechanical Engineers, and president of the American Consulting Engineers Council in 1972. In 1957 he was honored as an outstanding alumnus. William was active in Tulsa's civic clubs and the Unitarian Church. His wife Helen, a daughter, and sons William and D.K. survive him. Condolences from the class go to his family.

Editor's note: Since the loss of Mr. Mack, the Class of 1915 is without a secretary. Is there, perhaps, a volunteer who would be willing to help keep the class news going?Thanks go to **Evers Burtner**, *Box 286A, Rt. 1, Kingston, NH 03848, who reported for this issue but is unable to write the column on a regular basis.*

16

Mail bag is empty, so we made a few phone calls to gather some news for this column. We made five calls and were successful contacting all of those. **Barney Gordon** is fine, likes to be out in the winter air, and has been taking walks whenever weather conditions permit. . . . **Mickey Schur** tries to do the same and is very disappointed when he can't get out to walk. He is busy planning his summer vacation. He has engaged a place in the mountains in Austria for three weeks and will enjoy local sightseeing and walking. He will follow that with three weeks in Switzerland doing the same thing. . . . **Dan Comiskey** was out driving his automobile when we called, but Grace reported that both of them are doing very well. . . . **Hy Ullian** indicated that he and Frieda are both well, occasionally working together in his office and visiting their home on the Cape from time to time. . . . **Frances Duff** was pleased to tell us that she and Paul had a good winter in spite of the fact that they didn't get out much.They also were planning an exciting trip for mid-spring traveling to visit some of their children, making stops in California, Arizona, Kansas and Illinois.

We're happy that in all of our contacts we got good news, with everyone in relatively good health and quite active.Keep eating, drinking, walking, breathing, everything in moderation; and yes, of course, keep writing.—**Ralph A. Fletcher**, Acting Secretary, West Chelmsford, MA 01863

17 65th Reunion

Remember these dates: June 10, *Tech Night at the Pops*, and June 11, *Technology Day*, plus before and after for our own reunion activities.—*F.H.B.* (Secretary Pro tem: **Stanley C. Dunning**, P.O. Box 218, 33 Christian Ave., Concord, NH 03301)

18

I am grateful to still be receiving letters in reply to my Christmas greetings sent to all of you December last. A most welcome note comes from Washington, D.C. from **Bill Foster**: "While Beulah and I are still functioning at a reduced rate of speed, we still keep in touch with things through the written word and some modest trips in the neighborhood of Washington. We hope to spend a month in Florida soon away from this record series of days and storms. Beulah, unfortunately, has serious eye trouble which prevents her reading any normal printed word, and I am handicapped with Parkinson's, which necessitates my moving at a slow pace. We do have the good fortune of having numerous friends from our various activities of the past who are located reasonably close by, and this keeps us in general touch with activities in the foreign field, particularly with the government's arms control progress which, unfortunately, is not



An aerial view of the Technological Institute of Monterrey, Mexico, is the backdrop for this photograph of the late Don Eugenio Garza Sada, '14, whose philanthropy and sense of reponsibility to the Mexican people made possible the Institute's founding.

rapid as we would like and hope for. Answering your specific query, one must be optimistic that technology and its benefits far outweigh the destructive potential that also exists. It is, however, something that must be worked on long and hard. Our political decisions many times seem to have failed in making the proper choices which could give us relief from the threats and allow us to take advantage of technology's gifts. We doubt that we will be in the neighborhood of Cambridge reasonably soon but hope we are still around and are able to attend the 65th Reunion. Meanwhile, Beulah joins me in our best regards to you and Thelma and to all of our classmates."

Congratulations to **Ed Little** on his 88th birthday. I include excerpts from his round robin report to his family and friends: "This seems to have been Edward's big year.In late May he and Alice went to his 1916 Yale 65th reunion.Out of an initial class of some 400, there were still 52 graduates living, and 14 of these attended the reunion.Without doubt, the high point of the year for him was his 88th birthday-Thanksgiving day celebration at the home of their grandson and his wife in Belle Mead, N.J. The 14 persons present consisted of all three daughters, their respective husbands, and a grandchild from each family, plus two great-grandchildren. So wonderful was such an assemblage for his birthday that it left him completely overwhelmed and speechless." Ed adds, "You ask what M.I.T. did for me. It enabled me to get started in electrical engineering at the American Telephone and Telegraph Co., for whom I worked for 39 years and 8 months before compulsory retirement at 65. They were fruitful and happy years, and I did my little part in enabling direct distance dialing to make the necessary progress in circuit transmission maintainance practicable for nationwide service."

Our class was represented in the Alumni Fund fall telethon by **Len Levine** and **Eli Berman**. A spring telethon is coming up soon—May 10-13. Let us do more. . . . A note from Gladys and **Len Levine** reports that they are enjoying warm and pleasant weather at Pompano Beach.—**Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

20

Frank Maconi writes from Leominster, Mass. to let us know he is alive and kicking. Frank maintains an active interest in the SCORE group of Fitchburg and has participated in several retirement planning seminars at the Fitchburg Chamber of Commerce. Frank decided to turn over his 50-year collection of early country store items to his three grandchildren, swapping these valuable items for one of grandson's H.O. train sets. With the help of a retired neighbor he set up the railroad with all the fixin's such as villages, airports, bridges—"a wonderful outlet for pent-up energy." (What there is of it, says Frank.) He and Kay are already looking forward to the 65th Reunion. . . . A word from **Dolly Gray** of Sarasota, Fla. to note that he is in his 84th year. Glad to hear from you, Dolly.

Thanks to the sharp eye and consideration of **Norrie Abbott** I must inform you, with deep regret, of the passing of our remaining coed, **Dorothea Brownell Rathbone** on February 13 at Warwick, R.I. She was the widow of our classmate **Clifford Rathbone**. Born in Providence, she was a former member of the League of Women Voters, Society of Colonial Dames, and Providence Atheneum. She leaves a daughter, five grandchildren and two great-grandchildren. Dorothea was a loyal member of the class and attended many reunions. Norrie represented the class at her funeral.

Late but welcome word comes in from **Eric Etherington** who has moved from Lakewood, N.J. to Los Angeles (12412 Deerbrook Lane, 90049, about six miles from the Santa Monica waterfront). Eric has a granddaughter who is taking her M.S. at the University of California at Los Angeles but lives in Rome where she is associated with the U.N. Food and Agriculture Administration. Another granddaughter is finishing up at Wellesley. One grandson is attending Connecticut College in New London, and another is at the University of California at Irvine. He and his wife have three great-grandchildren in Virginia. A far-flung family like so many of us. Eric's son got his master's degree at M.I.T. Grand to hear from you, Eric.—**Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

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February is two-thirds gone as these notes are being written in Sarasota, Fla. It's been hot here, the warmest winter I can recall in Florida so that Betty and I get out frequently and walk on the beach of Siesta Key. One day we walked a mile up to the beach-front condominium of Kay and **Larcom Randall**. Larc has had further surgery since I saw him a year ago, and gets around in a wheel chair. But he is very cheerful, and it is fun to visit him. Our social life peaks every February, and we have had cocktail parties at the **Whittier Spauldings**, at Alice (Mrs. **Robert) Felsenthal**'s, a luncheon hosted by Millie and **Herb Kaufmann**, which included the **Josh Crosbys** and the **Sumner Haywards**, and other luncheon dates with the Crosbys. And it's not over yet.

A long welcome letter came in from class president **Carole Clarke** in early January just missing the April class notes deadline. Quoting in part, "We had our entire family here for Thanksgiving and spent a quiet Christmas and New Year's. Maxine's cataract operation and the lens implant have so far proven to be a masterpiece of surgery. . . . Alex (Mrs. **Munroe) Hawes** was operated on by the same surgeon for her glaucoma. . . . The past fall was so hectic I haven't done much thinking about the regional 1921 get-togethers I would like to arrange as a buildup for our 65th Reunion in 1986. I have had one request from **George Schnitzler** for an interim reunion. . . . India (Mrs. **David) Woodbury** has written that Dave is in a rest home. A letter from Vina and **Ray Cooper** discloses that Ray, who is suffering muscle weak-

How the Memory of an M.I.T. Alumnus Lives in Mexico's M.I.T.

The Technological Institute of Monterrey, Mexico (ITESM) which stands as a product of the effort and philanthropy of a pioneering, energetic, and committed M.I.T. alumnus, the late Don Eugenio Garza Sada, '14, is now gaining new prestige throughout Latin America. Today the Insitute receives students from all over Mexico, Central America and South America, and in addition to its Monterrey campus ITESM has generated specialized campuses throughout the country in an effort to meet the particular needs presented by each region. Over more than three decades of growth and development, the Institute has established a model of self-financing, supporting itself and many of its students through student fees, annual raffles, and extension activities. One out of every five students is on scholarship, and ITESM offers a wide range of study options in scientific and technological fields as well as in the humanities.

During the first 25 years after Mr. Garza Sada returned to Monterrey with his new M.I.T. degree, he was absorbed in the rapidly expanding industrial interests of his prominent family. His primary industrial affiliation was with the famous Monterrey beer industry that initiated subsequent development of the glass, steel and other capital industries in Monterrey and throughout Mexico. Indeed, today the Monterrey "group" of industries control a considerable portion of Mexico's industrial activity. At the time of his death in 1973 Mr. Garza Sada was the much-loved leader of this vast group.

Meanwhile, he founded "Monterrey Tech" as a response on the part of the private sector to Mexico's growing demand for highly trained engineers and applied scientists.

But Mr. Garza Sada had another interest in mind as well, for he firmly believed in free enterprise and that significant social responsibility was a corollary to the freedom of the firm.His commitment to this principle was reflected in the modern participative management philosophy that prevailed among his own industries. Mr. Garza Sada's work was meaningful to him, and he felt that it should be no less meaningful to the factory personnel. He saw the work place as a forum for self-realization and creative expression. Through this philosophy of leadership, through ITESM, and through many other philanthropic gestures to the Mexican community, Don Eugenio is remembered as a man committed to Mexico and to the Mexicans: to learning and to knowledge.

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ness, was in the hospital wing of Medford Leas (retirement village). . . . Anne and **Wally Adams** say they are staying home these days, and Wally is no longer playing golf. . . . **Bob Miller** wrote, "Thanks for the kind invitation to stop by when we next head north to Cape Cod. We hope to do that in late May or early June. . . . Mac and I are both busy with local affairs. Mac will deliver a paper next Tuesday to a book discussion group on the culture of early Mexican Indians. A while back I had an interesting day in Jersey City and the World Trade Center in New York when the Port Authority named a number of railroad cars for towns, including one for Brielle. As Brielle Borough historian, I prepared the text of the markers for the Brielle car." (Thanks, Cac, for a newsy letter.)

A phone call from **Irving Jakobson** told me of the death of **Ray Dunham Cooper** of Medford Leas, N.J. on December 18, 1981 - the date of the Coopers' 59th wedding anniversary. Because of poor health, the Coopers did not attend our 60th Reunion. Funeral services were held in Rockport, Mass. Ray worked most of his business career for Produce Terminal Corp., Union Stockyards, Chicago. He retired in October 1969 as general manager, electric power and steam, for the stockyards. Ray was an ensign in the U.S. Navy in World War I. . . . **George Schnitzler** of Plantation, Fla. says, "Anne and I took a 24-day trip to the Orient this past November. We visited Tokyo and other cities in Japan and then flew to Taipei in Taiwan. From there we flew to Hong Kong, the highlight of our fascinating trip, and then on to Bangkok and Singapore. Our last visit was to Honolulu before returning home. We noticed Western influence everywhere, with the most important second language being English (compulsory in public schools)."

A postcard just received from Helga and **Jim Parsons** mailed on board the *Royal Viking* from the South Pacific says, "We're living it up until the next reunion comes along. Give our best to all the gang." . . . **Bill Sherry** writes from Tulsa, Okla.: "I'm still pleasantly reflecting on our 60th—those attending were a light-hearted group. It was so good to visit with Helen (Mrs. **Raymond**) **St. Laurent** again. Both of our boys, Dick and Bill, have attended enough reunions over the years to be members of '21. I was surprised when I came home last June how many they asked about." Bill encloses several items of interest. The December issue of the magazine *Tulsa* features William Sherry, Jr. in an article on alcoholism. Young Billy, who came to several of our reunions, is now an administrator of employee assistance and recreation programs for McDonnell Douglas. The article quotes him on industry's need to deal with employee problems before they have a chance to escalate. Another enclosure, an article from the September 1981 issue of *Audubon* is about Dick Sherry—"A Hometown Wonder." Dick has been president and treasurer of the Tulsa Audubon Society and an energetic fundraiser for the Nature Center on Mohawk Park, Tulsa. Tulsa's park board changed the name of a lake to honor Dick. Bill's third enclosure is a recipe for spinach salad which he claims is the same served by the Eastern Yacht Club at our reunion luncheon last June. He offers to send it to anyone who writes to request it. Bill also encloses a list of family birthdays and anniversaries for children and grandchildren—a list that rivals Helen and **Bob Miller**'s. I'm not sure who is ahead.

Besides the death noted above, I am sorry to report that two other classmates have died: **Irving Kellogg Peck** of Hightstown, N.J. on December 4, 1981 and **David Oakes Woodbury** of Ogunquit, Me., on December 26, 1981. In addition to M.I.T., Irving Peck also attended the University of Illinois. He was president and general manager of the Binghamton group of Columbia Gas and Electric Corp. from 1935 to 1946, vice-president and general manager of the Pittsburgh group from 1946 to 1952, and vice-president of the Columbia Gas system from 1952 until retirement in 1960. Dave Woodbury was an author, teacher, and lecturer, writing suspense novels and books about science. He lectured at the University of New Hampshire. He graduated from Harvard, and also earned degrees at Stanford and M.I.T. He was an ensign in World War I aboard a submarine chaser and also served in the Navy in World War II. During his career, he worked for Pacific Telephone and Telegraph Co., for American Appliance Co., and as a research assistant at M.I.T. Author of 20 books, he also wrote for *Collier*, *Look*, *Reader's Digest*, *Saturday Evening Post*, and *National Geographic*. Our sympathy is extended to the families of these classmates.

.The following notes from Christmas cards were held over from the April class news because of space restrictions.

Helier Rodriguez and Graciela were planning to spend Christmas in Miami to be with Cuban friends and relatives. He tells of talking by phone to Claudia Crosby and learning that Josh has been successfully operated on. Said Helier, "We are looking forward to seeing you and Betty here in February." . . . Other Floridians, Beth and **Whit Spaulding** write, "With cold weather all over the East, the snow birds will be coming in droves next week. We'll be looking for you folks in February." . . . In a phone call to Helen (Mrs. **Raymond**) **St. Laurent** mid-December, we learned that she spent more than four months last summer and fall at Center Lovell, Maine. She said it was a happy summer with a lot of socializing. She saw the **Al Genaskes** on a number of occasions and reported that they had had cataract operations. . . . Pearl and **Horace Tuttle** report that 1981 was a bad year medically so that they were unable to come to our reunion. Says Tutt, "I have a few prescriptions to take, but otherwise feel just a bit on the lazy side. Pearl has developed a mean case of sciatica. Here we are—60 years out of M.I.T.—Wow!"

Hazel and **Whitney Wetherell** made a trip to visit Whit's sister in Hendersonville, N.C., in early October. Even with health problems they both got to our reunion last June! Said Hazel, "We had several pleasant M.I.T. and Simmons Club meetings this fall. **Don McGuire** has sold his house in Brewster and now is living in a condominium in Harwichport."

Dorothy (Mrs. **Joseph**) **Wenick** writes, "I have a problem with blood pressure but medication keeps me going. My son Martin is now charge d'affairs and counsel of embassy in Prague, Czechoslovakia. Dick will be down in Florida in January and I'll be happy to see him." . . . An Alumni Fund note from **Arnold Davis** tells of driving to Northeast Harbor, Maine, this past fall and visiting relatives along the way. He reports "reasonably good health."

—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Circle, Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

22 60th Reunion

On February 16 the Sustaining Fellows held a luncheon at the Sailfish Club of Florida, for the Florida area fellows. Alex W. Dreyfoos, '54, hosted the luncheon, and President and Mrs. Paul E. Gray were guests. A sustaining fellow is one who contributes $2,000 or more annually to M.I.T. or whose cumulative gift totals $25,000 or more. Classmates attending were **Francis M. Kurtz** of Delray Beach, **Frank O. Bickers** of Jupiter, and Mary and **Oscar H. Horovitz**. Oscar, also a Bronze Beaver holder, reports a magnificent clubhouse and a wonderful meal.

Randall (Bunt) Spalding writes, "I am indeed sorry that Spalding Inn Club is unable to extend an invitation to the Class of 1922 to return to the White Mountains for part of our 60th Reunion festivities on June 13. Unfortunately, all facilities were reserved quite some time ago by the Dartmouth Class of 1932 for their 50th, beginning on June 13. This conflict of dates is indeed a great disappointment as our 55th was such an enjoyable occasion from start to finish, and I had hoped that a repeat might come to pass. At any time previous to this date and after June 16, any and all members of the class will be more than welcome, and the Spalding clan will relish the opportunity to roll out the red carpet once again." . . . **Martha E. (Eiseman) Munzer**'s (Mamaroneck, N.Y.) latest literary doings is an article, "A Matter Of Morality—A Family's Letters On Abortion," which appeared in the *Tropic Magazine* (Sunday supplement of the *Miami Herald*) on December 20. It will also appear in the Hartford and Westchester (New York) papers (Gannett newspaper chain). Martha is looking forward to seeing everyone at our 60th. . . . Dr. **John W. Strieder** of Newton Lower Falls, Mass., reports he is still alive in spite of a report to the contrary in the class notes. John works part time in his practice, seeing old patients and doing some consulting work.

We received the December issue of the *Society of Amateur Cinematographers* in which **Oscar H. Horovitz** received a sterling silver serving tray with the inscription, "SAC Oscar H. Horovitz, Honorary President 1981." This was a special presentation for his many years of devoted service, accomplishments, and dedication to amateur film making. Congratulations, Oscar!!

We received a notice of the death of Dr. **Charles G. Moore** of Tempe, Ariz. . . . Ed Nealand, '32, has forwarded from Sandwich, Mass., the newspaper article regarding the death of **Daniel A. Brown** of Pocassett (Hingham) Mass. He lived in Braintree, Fort Lauderdale, and Pocassett for many years. Dan was a member of the Sandwich Yacht Club and is survived by his wife, Anna, and two daughters, Carol B. Basler and Judith Barrows. . . . Another death was reported by Bill LaLonde, Jr., '23, Short Hills, N.J.—that of **Karl Swell** in January. He was district plant superintendent for AT&T, Long Line Division. . . . We also report the loss of **Florence Stiles**, Meriden, Conn., who passed away in December after a brief illness. Florence, who was retired, worked several years in the architectural department of the University of Massachusetts, Boston. Previously, she worked as an architectural librarian and women's adviser at M.I.T. Florence is survived by her sister, Clara Braun of Hamden, a niece, and several nephews. . . . We are sorry to lose these good members. As always, the sympathy of our class is extended to their families.

Your secretary hopes to see many of our classmates at the 60th Reunion.—**Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, NY 14203; **Oscar H. Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, FL 33060

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Horatio Bond has been named 40th recipient of the Engineering Society of New England's prestigious annual award. It is presented each year "to



Horatio Bond, '23

a living engineer in New England who displays outstanding contributions to the engineering profession." Bondy was nominated by the New England chapter of the Society of Fire Protection Engineers. He joined that association in 1924 and served as its chief engineer for 30 years until his retirement in 1968. He then became an honorary member of the association as a self-employed consulting engineer in fire protection engineering practice. His assignments included working with the Office of Scientific Research and Development, the National Defense Research Committee, the U.S. Army Air Force, the U.S. Atomic Energy Commission, the National Academy of Sciences, and the President's Science Advisory Committee. He is a registered professional engineer in Massachusetts, an honorary member of the British Institution of Fire Fighters, and the International Association of Fire Chiefs, a life member of the American Water Works Association, and a member of the American Society for Public Administration, the British Fire Protection Association, the American Society for Industrial Security, and the Australian Fire Protection Association. He served as a member of the M.I.T. Corporation from 1953 to 1959. Further reporting on his career is in the October 1980 class notes. Currently he is writing a series of articles tracing the history of the profession.

Oswin W. Lowry reports that he has retired as president of Sligh-Lowry Furniture Co. but is retained on a consulting basis and has other business interests. These do not interfere with golf, tennis, and Florida in the winter, where he has a home in Boynton Beach.

Bruce B. Blake '57 reports the death of his father, **Winchester Gould Blake**, on October 12, 1981. Winchester graduated in mechanical engineering and went directly to the General Electric Co., where he was employed for 41 years until his retirement in 1964. He specialized in turbines, including mercury, gas, and steam, and became recognized as an authority in the field. He worked closely with customers, consulting engineers, and the company turbine shops to coordinate power plant designs. He was a fellow in the American Society of Mechanical Engineers and held life memberships in the Appalachian Mountain Club and the Adirondack Mountain Club.

John C. O'Flaherty died on November 21, 1981. He graduated in mining engineering. In 1949 he took a bachelor's in civil engineering at the University of Colorado. He was president of the O'Flaherty Construction Co. in Denver. He was also a registered professional engineer in Colorado, a fellow of the American Society of Civil Engineers, and a retired major, Combat Engineers, European Theater, World War II.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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It may seem premature to set the wheels in motion for our 60th Reunion, but personnel changes have been necessary. We lost **Frank Shaw**, our co-chairman, in July 1981. Executive vice-president, **Don Moore**, kindly agreed to replace Frank along with **Ed Moll**, the other co-chairman. Unfortunately, Ed found it necessary to resign because of illness in his family. Don called available class officers, **Herb Steward** and **Russ Ambach**, for a consultation luncheon. The reunion location seems to be settled, thanks to Ed and Don, but the big problem of 60th gift chairman remains. This will be discussed with Alumni Fund experts. Volunteers or suggestions are welcome. The need of a reunion co-chairman was satisfied by **Walt Bagley**, who graciously agreed to serve although he thought that living in Bronxville, N.Y., might be a handicap for discussion meetings.

We are sorry to report the passing of **Perry Maynard** on November 24, 1981, in Hastings-on-Hudson, N.Y. A note from Helen closes with, "Thus endeth 56 years of marriage! And it couldn't have been to a nicer guy!" Perry gained his S.B. in mechanical engineering and was commissioned a second lieutenant, ordnance, U.S. Army. He joined New England Telephone in Boston in 1924 and climbed the AT&T ladder via Springfield, Detroit, and New York City, spending four years in the Pentagon during World War II as chief of Traffic Operations Branch, where he was commissioned a colonel and awarded the Legion of Merit. He retired in 1967 following various executive positions with AT&T in New York City. In 1939 he was secretary of the Technology Club of Detroit and later of the Board of War Communications.

The Alumni Association has advised of the death of **John W. Cannon** on December 31, 1981, in Plainfield N.J. He was our class co-agent. Jack was awarded his S.B. in general engineering and after a few years joined Continental Electric Co, Inc., Newark N.J. for his entire career. During his senior year he was a member of several class committees, and for three years the Aeronautical Engineering Society. He received an award from the M.I.T. Club of Northern New Jersey recognizing his efforts on its behalf.

Sam Zerkowski, Slidell, La., prints a note on his telethon pledge: "I have been retired since 1962 and have been very active in the culture of the beautiful camellia flowers and plants. My wife started it as a hobby, and together we have collected and developed one of the largest collec-



Because he could "make a battery ring a doorbell," Herbert R. Stewart of Woodland, Maine (population 2,000), was encouraged by his high school teachers to come to M.I.T. That was back in 1919, and when Mr. Stewart enrolled as a member of the Class of 1924 he was the first student from Woodland ever to come to the Institute. As his career in electrical engineering flowered—Mr. Stewart is a retired senior engineer with the New England Electric System (now living in Waban, Mass.)—Mr. Stewart maintained his ties with eastern Maine by reading the Calais Advertiser, where last summer he discovered that Woodland was about to send its second student ever to M.I.T. He's David Libby, '85, whose Institute career is now well launched. (Photo: Calvin Campbell)

tions in the world. Visitors come from Japan, China, New Zealand, Australia, Europe, all over the U.S.A., and some parts of South America during the blooming season (September to April) anticipating the new varieties to come. A visit will be remembered and admission is free!"

Phil Bates (Dr. P.K.B.) writes from Santa Monica, Calif., "Jacky and I went heli-hiking in the Canadian Rockies, Lake Louise, etc. A helicopter takes you up the mountain, and you can walk until the helicopter picks you up. Grand scenery." . . . **Ed S. Taylor** has time to tell us about his retirement: "Manage to get in a bit of woodturning and silversmithing between maintenance, plumbing, and appliance repair. Summers, my wife and I go cruising in a 23-foot Herreshof—Maine coast for June and July and settle down on Chappaquiddick Island (swimming, sailing, loafing, etc.) for August and September. Do occasional consulting.."—Co-secretaries: **Russell W. Ambach**, 216 St. Paul St., Brookline MA 02146; **Herbert R. Stewart**, 8 Pilgrim Rd., Waban MA 02168

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Your class officers had an enjoyable gathering prior to the January meeting of the Alumni Council. The group included **Jim Howard, Courtenay Worthington, Willard Gardiner, Ed McLaughlin**, and yours truly. Acting as the executive committee of the class, we voted to make Joe Martori, associate secretary of the Alumni Association, an honorary member of the class. Those of you who have attended recent reunions will remember Joe, who was so helpful in coordinating our activities, and we felt strongly that we would like to have him associated with 1925.

It is with sorrow that the passing of two classmates must be reported. **William French Arnold** of Charlestown, R.I., died on November 4, 1981 at the Scallop Shell Nursing Home in Wakefield. Bill has not been active in class affairs in recent years, but many times in the past he worked on reunion committees. He was a retired commander in the U.S. Navy Reserve and served in the Pacific Theater during World War II. Bill had been employed as an electrical engineer with the Sprague Electric Co. in North Adams, Mass. He is survived by his wife Elizabeth (Chalmers) Arnold, two sons, a daughter, a brother, eight grandchildren and one great-grandchild. Also, on October 28, 1981, **Meyer Shacat** died in Miami, Fla.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

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We recently received from our class treasurer, **Pink Salmon**, his annual report including the 55th Reunion figures. The treasury is in sound, if not prosperous, condition, well able to cope with our planning activities for our mini-reunion in 1983 and our 60th in 1986. In his report statistics of our reunions were listed which we thought quite interesting:

Reunion year	Number attending	Living
30	153	750
35	132	720
40	218	691
45	193	674
50	140	521
55	130	347

On a recent vacation in Florida **Jim Killian** met **Smith Turner**, who is retired from the Exxon Corp. and now living in Greenwich, Conn., not far from another Exxon alumnus **Dave Shepard**. According to Smith, Dave has recovered well from a recent illness and the loss of his wife last year.

You may have heard from **Don Cunningham**, who represented the class in the Alumni Fund fall telethon. . . . **Allen Cobb** writes, "I am now quite fully retired. I, however, am very active in my church, am back to high school for some woodworking experience, have been restoring antique clocks for some time, and am now building a clock case to my own design. My family is well, a granddaughter married." . . . From **Elton Staples** a note refers to his pleasure at the 55th and to the fact that he has relocated in both Chatham, Mass., and Orlando, Fla., to smaller properties which he can enjoy for years without all the yard work. "We still grow camellias in Florida and try to enjoy a lazy summer in Massachusetts. Drop in at Chatham or Winter Park." . . . A card from **George Makaroff** states, "Just for your 1982 records, George A. Makaroff—'present and accounted for' (I hope, I hope!)."

A letter from his wife Marion tells us of **Ken Lord**'s death on December 1, 1981, and adds, "He was always devoted to M.I.T., but because of ill health he could not participate in his reunions and could not travel." The regrets of the whole class are extended to the memory of one of its most active and loyal members.—**William Meehan**, Secretary, 191 Dorset Rd., Waban MA 02168

27 55th Reunion

This is our last report before our 55th Reunion and Chairman **Ray Hibbert** is glad to report that we expect about 75 each at Cambridge and Wianno. The committee has planned an active Wednesday eve through Sunday program. We begin with a reception and catered dinner at the M.I.T. Historical Collection on Mass. Ave. at 6:30, Wednesday, June 9. Any classmates who would like to join us, but who have not signed up for Cambridge events, will be welcome.

George Cunningham had a splendid three-week visit to People's Republic of China, including an 800-mile cruise on the Yangtze River and a Great Wall exploration from Peking.Unfortunately, George lost his wife to cerebral meningitis in Hawaii on their return home. However, he still plans on attending our 55th. . . . We are very sorry to report the death on January 20, 1982, of **Harry J. Moser**. From the report of his good friend and fellow patent attorney, **Theodore Ordman**, he died suddenly from a heart attack at his home in Asheville, N.C. He and Pauline had made plans to attend our reunion. We do hope Pauline will come.



. . . The widow of **William J. Rudge**, Anne Rudge, kindly sent a check to our class in his memory and thanked us for inviting her to the reunion. . . . A belated report from the Alumni Office gives December 5, 1980, as the date of **John E. Gill**'s death. He was in the leather business in Ipswich and in 1950 started a business in Puerto Rico. He returned to Wayland in 1960.

With the conclusion of these notes, your secretary pro-tem is soliciting a volunteer among our classmates for co-secretary. Most classes of our vintage, you will note in the *Review*, have appointed a second secretary. It is a good idea to have a secretary distant from Cambridge, someone in Florida or California to help keep in touch with more classmates. It would be a great boost to me, if I am elected at the reunion meeting, to know that a co-secretary is gathering news to include in our notes. Furthermore, as you glean from the notes, even M.I.T. men are mortal.Looking forward to seeing many of you at the reunion and sharing our living enjoyments.—**Joseph C. Burley**, Secretary pro-tem, 5 Hutchinson St., Milton, MA 02186

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As you read these notes the 55th Reunion will be only a year away. This still gives you plenty of time to prepare for the event. You should definitely plan to attend—there is nothing quite like a '28 class reunion (as many of you already know!). . . .. And before we leave the subject of class business, Frannie and **Jim Donovan** and Florence and **Walter Smith** wish to thank all those who responded so graciously to our telephone calls during the recent Alumni Fund fall telethon.

In a letter to Jim, **Harold Bialkowsky** described some of the conditions relative to the St. Helens eruption in 1980. Harold and wife Margaret live only about 25 miles from the mountain but, fortunately, in the 60-degree sector due south of the cone where there was little, if any, damage. However, Harold reported that Jim's birthplace, the Fort Vancouver barracks, got a real good dusting as did Portland, Ore. Apparently all goes well with the Bialkowskys and their offspring families.

Also, in a letter to Jim, we have an update on **Gabe Disario**. The Disarios have a new address in Venezuela which we will gladly supply to you upon request. Gabe and Helen celebrated their golden wedding anniversary last September with a Mass and party at the home of their younger daughter (also named Helen). Gabe's older daughter, Caroline, graduated from M.I.T. in 1956, Course I. Then Caroline's own daughter graduated in 1979, and now a son is a student in the Class of '83. On every count, our hearty congratulations to Gabe, Helen, and their whole wonderful family!

A news release from the New Jersey Public Health Association, dated December 4, 1981, tells us that **Roberta Lovely Halligan** was the recipient of the Association's Sullivan Award. This honor was granted in recognition of Roberta's many accomplishments during her long career as a public health officer in the State of New Jersey. To you, Roberta, our admiration and congratulations!

At year's end we had a letter from **Lazare Gelin**. He and Irene have been doing some traveling recently for relaxation. This has included a few weeks in Spain and Portugal, a trip to Greece, and a projected Caribbean cruise. While in Greece they tried to locate **John Houpis** but without success. Oddly enough, we had a note from John at about the same time. He is still just as eager to have classmates and other friends call on him when in Greece. We suggest that you travelers alert John in advance and avoid any disappointment.

Among other notes we have one from Mary and **Max Parshall**. They had a good year in 1981 and hope that they can make the trip to Cambridge for the 55th. . . . A Christmas card color photograph of Elsie and **Bunny Burnell** shows them looking happy and very well. . . . **Bill Hurst** (who is probably our best class mathematician) looks back to the honest hardships that many of us endured as students and deplores the unrest and violence so prevalent today. . . . In a very brief note, Margaret (Mrs. **Vernon S.) Brown** says that she is so glad that she and Vernon were able to be at the 50th in 1978.

With deep regret we must report the deaths of three classmates. **William R. DuVernet** died suddenly on November 6, 1981. The information was provided by his wife, Margaret. After graduating in mechanical engineering, Bill's whole professional life was in communications engineering with 41 years of accomplishments for the New York Telephone Co. Throughout the years he has been a very consistent and loyal supporter of M.I.T. The DuVernets have two sons and two daughters.

Peter H. Kirwin died peacefully on January 18, 1982, following a heart attack. A letter from his daughter, Eileen, provided this information and went on to say that Pete had lived for 40 years in the New York metropolitan area working for the Diehl Division of the Singer Co. After retirement (and for the past seven years) he has thoroughly enjoyed living on the coast of North Carolina. He was very proud of his M.I.T. background (an electrical engineering graduate) and loved to tell of his student days. Those of you who were at the 50th Reunion will remember how Pete jumped up on the platform to lead us in a hearty technology cheer as the class gift was presented. Besides wife Mary, he leaves two sons, two daughters, and 11 grandchildren.

Henry E. Simonds, a business and engineering administration graduate, died suddenly at his home on January 29, 1982. After retiring from a life of various business activities, Henry embarked on a new career that brought him local and national fame. He became the unoffical historian for his native town of Winchester, Mass. In the course of this work he made a study of some 500 historic houses in the town. His excellent work won for him a certificate of commendation from the American Association for State and Local History. His was a lifetime of generous service to his town. He leaves a daughter, three grandchildren, and a great-grandson. His wife, Edna, died in 1976. His father was Roland E. Simonds, '01. To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Donald S. Hersey of E. Hartford, Conn. writes, "I have now been retired from Pratt and Whitney Aircraft (engineering department) for over 14 years, and have lived harmoniously with my wife Eleanor in our longtime home, both before and since my retirement. Physical activities have diminished somewhat, but I still spend considerable time painting (art), playing the piano, playing bridge, and keeping up with current events. I also prepare some of the simple meals, to make Eleanor's task a little easier." . . . **Edward D. Thomas** of Foxboro, Mass., sends a note: "We still go to square dancing regularly. Evelyn is recording secretary for the National Society for the Preservation of Covered Bridges, while I am secretary for the Connecticut River Valley Covered Bridges Society. We observe the medical advice that was given to us—to walk at least three miles a day or attend square dancing. We do both." . . . **Joaquin J. Llanso**, of Williamsburg, Va. writes, "I recieved your birthday greetings on my 74th birthday, via Houston, Tex. Until last May, my wife Dorothy and I resided in Houston. My three-year consulting contract with Knight Industries, of Broken Arrow, Okla. ended at that time, so we moved to Williamsburg where we had bought a house back in 1964 and rented ever since. Ostensibly, I was starting, at long last, full retirement. But it only lasted 30 days when I was approached by a number of our former competitors, asking me to do the same sort of consulting work that I had been doing for Knight. One of these was Worthington, division of McGraw Edison Co., where I had worked from 1929 (right after graduation) to 1963 when I joined Knight Industries, eventually becoming its president. In conjunction with my part-time consulting job with Worthington, I have made nine trips promoting the application of their compressors to natural gas field operation in South America. Two of the trips were to Peru, Argentina, and Venezuela, and the others to points within the U.S. We have now settled here, more or less, though we do miss the more balmy temperatures we enjoyed in Houston.The snow, freezing rain, and sleet, plus unusally low temperatures since the first of this year make it difficult for us to get used to it. We have three children. Martin, the oldest son, joined Armstrong Cork Co. upon graduation from Cornell; our second son is deceased; and our daughter, the youngest, received her B.A. from Vassar and is currently studying for her Ph.D. in psychology from Oklahoma State University. Dorothy and I take this opportunity to send you and all other classmates our best wishes."

Eric A. Bianchi of Tequesta, Fla., says, "Kay and I celebrated our 50th wedding anniversary in October and my 75th birthday a few days later. To celebrate we journeyed to Detroit to see our son and his family now residing in Grosse Pointe Farms, where he is chairman and CEO of Johnson and Higgins of Michigan. I am still busy running the Fluid Control Institute, a trade association of about 100 companies in the U.S. and Canada. This keeps me busy part time without getting in the way of my golf game. Best regards to all." Most of Eric's professional career has involved general management: with Masonellan International of Norwood, Mass., he was sales manager, director of engineering, vice-president, and president. Later in his career, he joined Studebaker-Worthington Corp. of New York as director of planning. He has made a major contribution of his

A happy reunion (left) for Elise and Warren Walker, '29, of Montclair, N.J., surrounded by their nine grandchildren who visited them last August.

time and talents to class affairs, having the enviable record of attending every major five-year reunion except the 15th and the 50th, which is 80 percent. He is also one of our distinguished past presidents of the class. . . . "Old Faithful" **Dave Wilson** of W. Newton, who never forgets to send me news, writes, "My wife Ethel and I have three children and 11 grandchildren. I'm still active in my business (manufacture of brassieres) which I didn't mind in spite of the usual problems that most small businesses have, such as personnel, financing, sales, and union problems. Ours is a relatively small concern which employs approximately 300. Sometimes I think the larger the business, the easier it is to run. I keep reading in our class notes about the Grim Reaper taking his toll on our classmates and was especially shook up when I read about **Jim Fahey**'s passing. It is always a pleasure to see you and others in our meetings at M.I.T., and we are looking forward to our 55th Reunion at Chatham Bars Inn on the Cape."

Butler King Couper of Tryon, N.C., has received his general class license for his ham radio call "KA4ADZ," and he is studying for the advanced grade. "Ham radio is a world in itself, a conglomeration of persons from all strata of society brought together by a common tie of friendship.In today's world, a real courtesy is a delight which is something enjoyed by our amateur radio society members. I enjoy reading your excellent class notes every month, for which you have my appreciation along with other classmates.My best wishes to all my friends, particularly to **Frank Mead** and **Bill Baumrucker**." . . . **John D. McCaskey** of St. Joseph, Mo., sends greetings to all his classmates and best wishes for 1982. "Keep up the good work," he concludes. . . . **Gus Stein** of Boca Raton, Fla., writes, "I have been a member of the M.I.T. Club of Palm Beach County for three years now and have attended 90 percent of their meetings and enjoyed them. Best wishes to you and the rest of our classmates. Let us hope we'll have better luck getting together this year." . . . **Hyman J. Fine** of Norfolk, Va., has retired from the Corps of Engineers, U.S. Army, and presently is employed as a part-time consultant on planning water resources development projects. He presented a paper, "Social and Legal Problems Pertinent to Tidal Protection Measures," at a National Symposium at Virginia Polytechnic Institute. He is a member of the senior adult committee of the Community Center and the auditing committee, Four Cities United Way. He visited Israel last year and, since his return, has shown slide programs to many community groups. He plays in tennis tournaments and recently came home with a "tennis tote" from one.

Earl Erickson of Burlingame, Calif., writes, "Our big event this year was the birth of two granddaughters and the expected arrival of a third great-grandchild. We had a delightful cruise this fall in the eastern Mediterranean, visiting Greece, Turkey, Egypt, and Israel. One of my present hobbies is trying to learn how to deal with the IRS. I was sorry to read recently in the class notes of the death of **Jim Magenis**. I was disappointed that he was unable to attend our 50th Reunion. Best regards to all." . . . **Louis F. Southerland** of Austin, Tex., writes, "Since my retirement two years ago after 45 years of architecture and engineering practice, my wife Jean and I have enjoyed traveling. We have recently returned from an excellent cruise in the Mediterranean on the *Argonaut.* My chief hobbies are watercolor painting and bird hunting with my own dog. My son and I have planned a bird hunting trip next summer in South Africa. I am so busy in retirement that I need an assistant. Jean and I are looking forward to our 55th Reunion." . . . **Takanao Kuki** of Tokyo, Japan, sends a brief note with an open invitation for any '29ers visiting Japan to look him up. His office is located in Tokyo, and his telephone number is 271-5581.

Lawrence S. Newman of Delray Beach, Fla., writes, "In June we celebrated our 50th wedding anniversary by taking a trip to Norway and Denmark. The highlight of the trip was a 12-day boat ride up the Norwegian coast from Bergen. One of our hobbies is square dancing, which occupies most of our time in Florida during the winter. It is good exercise, physically and mentally. We also like deep-sea fishing in Maine during the summer months. In between, we do motor home traveling around the country."

John F. Joyce of Drexel Hill, Pa., is still working, but his interest in it is diminishing. "Mary and I are leaving on Sunday for two weeks in Florida. We will see classmate **Harry Dickinson**, who lives in West Rotunda (near Ft. Myers). Beyond the short stay in Florida, we will spend most of our time at home. My wife Mary enjoys the children and grandchildren too much to leave the area. Best regards to all." For the past 36 years, John has been in the business of buying and selling industrial electrical machinery. His son John Jr. joined the firm in 1971 in charge of reconditioning electrical equipment. Prior to his establishing his business in 1947, he was associated with Philadelphia Electric Co. for 14 years. . . . Elise, wife of **Warren W. Walker**, of Montclair, N.J., sends a copy of her 1981 family news, which begins, "According to a Chinese proverb, 'a picture is worth a thousand words.' With that in mind, I am enclosing a brief note and a picture of us taken with our nine grandchildren in the garden in August 1981. The occasion was a happy reunion with Robin, our daughter, and her children who came east to escape the Texas heat." As a sustaining member of the M.I.T. Corporation, Warren has had some unusual opportunities for meetings in Cambridge. He is also on the board of directors of Yonkers' Chamber of Commerce, Yonkers General Hospital, and the American Association for Industrial Management, to which he contributes a monthly newsletter for members. Both Elise and Warren maintain their interest in the Presby Memorial Iris Gardens.

Excerpts from the 1981 news from **George J. Meyers, Jr.** and his wife, Barbara, of Wyomissing, Pa.: "This has been a busy and happy year, especially from July on. July 4 is always a joyous time because Bill, our son, brings his family down so that grandson Jonathan can celebrate his birthday with the Wyomissing Parade. Had a beautiful four days at Adelynrood before going up to Passaconway, N.H., for a week with the Kingsleys. About our robbery of July 1980, the police raided a house near Harrisburg, looking for drugs. Instead, they found it full of stolen property from this area. Police jumped for joy when we conclusively identified two of our smaller rugs. George's activities are unchanged, except for helping teach electrical machinery to 20 sophomores at Penn State's Berk campus, winter semester.Barbara was chairman of the community service committee of the Soroptimists, which put on a very good hospice seminar in May. Both George and Barbara play tennis regularly, and Barbara has tried to get her mile-or-two walk in on non-tennis days."

At last, our class widows' program, which has been mentioned before, is about to become a reality. **Bill Bowie**, our president has sent me a note about that proposal, which is very favorable. He says, "I think it is a capital idea and a fine way to keep in touch with some fine friends. Rather than waiting for an executive committee to get the program started, I suggest that you start the ball rolling in your class notes and see what develops." Our records show approximately 100 potential widows who may participate.Within the past year or so, the following candidates have personally approved and/or initiated the idea. They are: Dorothy (Mrs. **Walter H.) Partridge** of Andover, Mass., Ruth (Mrs. **James) Fahey** of Dennis, Mass., Polly (Mrs. **John) Osborne** of No. Hampton, N.H., and Elli (Mrs. **Sol) Horwitz** of Brookline, Mass.Initially, your secretary will act as the coordinator until such time when the enrollment to the program reaches ten members, at which time a coordinator for the widows' program may be elected to carry on the work. Soon a letter will be sent to all the widows of the Class of 1929 that we have the records of (back to 1965) asking their opinion and giving them an opportunity to join. As our president stated in his note, "This is a good idea, and we should start it soon.We may have a good chance to bring some of them to our 55th Reunion."—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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Mel Blackwood has had a varied career in such fields as textile development, chemical sales, plastics engineering, and electrical connectors. In the late sixties he switched from industry to teaching and taught physics and mathematics at technical schools and junior colleges in Connecticut and New Hampshire. During the teaching part of his career he used his free summers to build a house on a 15-acre tract of woodland in Sanbornton, N.H., where he now lives. Mel is a member of the Lakes Region Planning Board and is active in church work and the local historical society. He reports that he has had a couple of heart attacks from which he has recovered completely. The Blackwoods spend about three winter months in Silver Springs, Fla. . . . **Bill Alling**, one of our three clergymen, although semi-retired, is still doing some teaching at the Westminster Christian Academy in Huntsville, Ala., specifically New Testament Greek and Algebra II. He is also associate pastor in charge of visitation at the Reformed Presbyterian Church. He reports: "The only change is that I'm a few years older, but the Lord keeps me in good health, and also keeps me busy." . . . **Reg Bisson** retired from his construction firm, W. M. Bisson and Son of Laconia, N.H. in 1976 but still does some consulting work in the construction field. He has remained active in the Laconia Rotary Club and Chamber of Commerce and is on the investment and appraisal committee of the Laconia Savings Bank, of which he is also a trustee. His hobbies include amateur numismatics, fishing, and photography "with a 40-year old Leica that still produces excellent pictures."

By virtue of letters from Arthur MacKusick, '32, and from **Bill Waite**, we have learned that Arthur's brother, **Byron MacKusick**, died suddenly of a heart attack at the MacKusick's "family summer homestead" in West Southport, Maine on September 10, 1981. As many of you know, after graduating from M.I.T. Byron went to work for Standard Oil of New Jersey. Some years later he moved to Pure Oil where he worked at the research laboratory in Crystal Lake, Ill. until his retirement. He spent vacations and retirement summers in Maine, doing much boating and fishing. Also after retirement he became an avid bike rider. At the time of his death he was a widower; his wife Ruth died about six years ago. He is survived by two sons, Meredith of Bethesda, Md. and Kingsbury of Crystal Lake, Ill., a daughter Sara who lives in California, and six grandchildren. . . . A letter from **Allan Meinecke**'s wife Elizabeth tells

of Allan's death of a massive stroke on December 4, 1981. After receiving a Course IV master's degree in 1930, Allan established his own architectural firm. He spent some time in Alaska during World War II and thereafter became associated with Ellerbe and Co., architectural engineers in St. Paul, Minn., where he worked until his early retirement for health reasons in 1969. Since 1974 he had lived in California. Allan married twice. Elizabeth Dreher Meinecke, from whom I received the notification of his death, was an old friend of his first wife who died in 1972.Elizabeth and Allan were married in 1978 and did considerable traveling during the few years they had together. He is survived by two daughters and several grandchildren. . . . Still further, we have received notices concerning the deaths of **Daniel V. Lucey** of Wakefield, Mass. on October 12, 1981 and **Walter B. Parker** of Keene, N.H. in early November 1981. Unfortunately, I do not have any information at all about Lucey in my files. Parker was an Amherst graduate who did graduate work at M.I.T. in 1930 and is reported in the *Manchester Union Leader* as having received an "engineering certificate."—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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The following letter from **Arnold Childs**, whose winter address is 8625 Midnight Pass Rd., B 508, Siesta Key, FL 33581, brings us up to date on his activities since his retirement: "I maintain that I can keep awfully busy doing nothing. (Note: Join the crowd, Arnold.) We do get in a bit of bridge and I like to walk the beach each day. We have quite a number of friends that spend all or part of the winter season here on Siesta Key, so we do a lot of visiting, eating out, and attending performances at the Van Wezel Hall. Also, this year I am in charge of the social committee here at Bay Tree Club (120 units), so I have been occupied with getting that set up for the year and with arranging cocktail parties, dinner theater nights, trips to jai alai, etc. Otherwise, I do little here during the six months that we spend here. From mid-April to mid-October we live in Thornton, N.H. We consider that our home. When I retired from Sun Oil Company in 1966, we left Philadelphia to return to New England. We found what we were looking for in a 200-year-old house right in the mountains. We look 18 miles up the valley to Cannon Mountain where the Old Man of the Mountain is. We do enjoy our summers there, especially as we are visited by many friends who are vacationing in that area. Effie and **Skeex Dean** have seen us several times.To get the old house we had to take five cottages that were part of the property. When we bought it, I thought that we would sell off the cottages to friends who might like to have a small summer place. As it turned out, we have had so much fun with the 'guests' that have rented the cottages that we did not sell them. Many of the guests have been spending vacations there for many years. We now consider many of them good friends and have looked forward each year to their coming back. Consequently, my summers have been occupied maintaining the cottages. But last summer we arranged to sell the cottages to a young couple who will operate them just as we have. Hence we shall have the fun of the friends that come there, but none of the responsibility or work. Our friends and relatives who have stayed in the cottages will now come just the same but will pay rent to the new owners. Rita and I keep well. After retirement we spent our winters between Siesta Key and freighter trips. We rented here during those years so were free to travel. We have had some fine trips, lasting as long as four and six months, and did get to see much of Africa, India, South America and other warm-climate countries. Our traveling days are over, however, as Rita has glaucoma and her eyesight makes it not so much fun for her to travel. One of our sons, Robert, works for Metropolitan Life in N.Y. He lives in Rye and has a wife, a son, and daughter. Our second son decided, when well-established in his early thirties, to go into the ministry. He left a good job, went to Bible Institute, and is now a missionary in Nigeria. He, his wife, and two children live in Benin City and love it there. They get back here each summer and spend a couple of weeks with us in Thornton. When it is time to return to Nigeria, all of them are longing to get 'home' to Nigeria. Their oldest daughter is now married and presented us with our first great-grandson last October."

Louise and **John Swanton**'s Christmas letter reported on their activities during 1981. Although space does not permit including the entire letter, which I would like to do, the following quote is of particular interest to all: "Toward the end of last year John took note of an M.I.T. gathering to be held at Cypress Gardens, Fla., in February 1981 and said, 'Let's go!' We'd never been to Florida in the winter and many of our family and friends now live in that direction and had said, 'Do come and look us up when you go South'. So with malice aforethought when we sent our Christmas greeting to them last year, we asked if anyone would like to see us in February 1981. Ninety-five percent wrote back to say they would be looking for us. So we stayed with 14 different families and renewed many friendships. We were also getting very interested again in stars and space so decided to visit all the space museums we could enroute—five, counting the wonderful space museum in Washington, D.C. Also nearby is the Goddard Space Center at Greenbelt, Md., named for Robert Goddard who made space trips possible with his rockets! The most outstanding by far is the Marshall Space Center in Huntsville, Ala. It has the trailer the orginal astronauts called home while in quarantine; the monkeys that went up into space; the piece of Skylab retrieved from Australia, all burnt! At Kennedy Space Center, Cape Canaveral, we saw the shuttle before it went into space. The last of the space centers we stopped at was at Langley Field, Va., on route home, a smaller one more like the Goddard at Greenbelt. We enjoyed them all and learned a great deal." With respect to our 50th Reunion, Louise and John renewed many friendships among the classmates and made new ones.

Dorothy and **Dave Buchanan**, our class prexy, wrote that they had just gotten home from Alford, N.H., where they helped their daughter-in-law when she came home from the hospital with their seventh grandchild, Lisa Allison Buchanan, born December 1. Dorothy and Dave were delighted to have a girl and they say she is a "little doll." . . . **Claude Machen** sent a letter he received from **Raymond Jacques**, dated November 13, 1981, which said, "Sorry that I was unable to attend the 50th Reunion. As you may recall, I served on the 25th Reunion Committee and my wife, Margaret, served as host for the ladies' night affair. I enjoy good health and live alone, Margaret having passed away in 1968. Fortunately, I have one son and two lovely grandchildren, a boy and a girl both under five years of age. I keep busy during the summer at my waterfront cottage in Rhode Island on Narragansett Bay where I have enjoyed vacation living for the past 22 years." Many thanks, Claude, for passing this information along to me.

We also receive news of **Emile Grenier**'s activities during 1981. Emile spent over $30,000 of his own money battling a federal government requirement that new cars have automatic seat belts or air bags, and finally won out based on test and other scientific data. Emile, congratulations! During 1981, Ella and Emile took a trip to Paris with a University of Michigan alumni group and covered more in the eight days he was in Paris than most people do in several months. His 1981 activities included attending our 50th Reunion on Martha's Vineyard and getting together with his brothers for the first time (all together) in 35 years. All the best to Emile and Ella.

A Christmas card brought us news of **Bill Stellrecht** and his wife with the promise that he will send a fuller report in the near future. All of us, I am sure, will look forward to hearing from Bill who lives in Stuttgart, Germany. . . . Notes from the Alumni Association from **Chauncey J. Hamlen, Jr.** quote him as saying, "A year ago my wife and I pulled up stakes in Pasadena, Calif., and moved to Lake Havasu City where the air is clear and the boating superb. I had lived in Pasadena since 1946 when I came to California to get involved in rocketry at the Caltech Jet Propulsion Lab. In 1949, I joined North American Aviation's (NAA) Aerophysics Lab, where I was engaged in rocket engine development until my retirement in 1964. I was fortunate to work with Dr. Werner Von Braun for six years as NAA project engineer on both the Redstone and Jupiter programs."

Some time ago, I received a note from our class prexie, **Dave Buchanan** saying that Evelyn and **Howie Richardson** were in China. No further details were given, nor have I heard from Howie. . . . **Claude Machen** very thoughtfully has sent me a copy of the notes received with checks for the Class Book which I believe you all received. Several of our classmates simply acknowledged receipt of the Class Book and included a check.**Dick Blasdale** wrote Claude that he had used the Class Book to send a letter to **Ducky Graham**. Dick also said that he was sorry to have missed our 50th Reunion but his legs just won't carry him too far afield. Dick's wife Rhona passed away quite suddenly just after he retired about three years ago. Quoting from one paragraph, Dick writes: "I am fortunate to have my son and his lovely wife living in the same town with me, and I have two fine grandchildren who are a continuing source of delight—Spencer, 13, and Amy, 8."Our condolences to Dick on the loss of Rhona. . . . Another letter told of **C. Gideon Rice**'s death in the spring of 1981. . . . **Horace Ford, Jr.**, wrote: "Sorry to have missed the reunion but it was a long way off and, for us, Vero Beach (just north of us) is our 'Dew Line', although we were back in Connecticut and on Long Island in mid-summer to visit with grandchildren. You'll note that our address has changed. We now live in what I believe is the only condominium mobile home park in Florida. It is a beautiful place to live—200 homes with our own heated pool, marina where we moor our Rhodes/O'Day Mariner II sloop—a place so well kept and manicured that its streets are almost clean enough for your scrambled eggs and bacon!" Horace's address is 208 Hidden Harbour, Stuart, FL 33494. . . . Congratulations to Colonel **Fred Elser** and Mardy on their 50th wedding anniversary early in February. Lately conditions haven't been too good for our ham radio contacts, but will keep trying every Sunday. . . . **Claude Machen** writes that he had a great Christmas and is now busy working at programming his Christmas present from Jean, a minicomputer.

These notes were written late in February just before Helen and I left for the M.I.T. Mexican Fiesta in Yucatan. We are hopeful that other members of our class will be there.In closing, we regretfully report the death of **Jerome J. Collins** on August

28, 1981, and **Curtis B. Brown**, of whom we have no further details. Our sincere condolences to their families from all of the Class of 1931.—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton MA 02158; **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

32 50th Reunion

By the time you read this, our 50th Reunion will be upon us. Those of us who make it will miss those unable to make it.

A good many classmates list among their hobbies working for a church. **E. Harold Anderson** retired in 1971, and since then he and his wife have been active as lay missionaries with the Galilean Baptist Mission planting New Testament Bible Churches in the United States. . . . **Thomas H. Anderson, Jr.** writes a most interesting letter summing up his life's work. It is full of technical exploits and human qualities. He worked with Standard Oil of California for ten years, but the work and conditions were not satisfactory to him. so, he bought and operated an orange grove, but rapidly dropping orange prices forced him to quit. By this time he had five mouths to feed. He joined C.F. Braun and Co., contractors, as a project manager. There he found professional happiness. The company took on many challenging jobs, which they often finished ahead of schedule. He tells one story of how they built a "hydrocracker" that produced heating oil so water-white and free of odor that the first shipment was returned by the distributor because he was afraid his customers would "accuse him of putting water in their fuel tanks."Because of his wife's failing health, he finally retired to San Clemente for weekday golf and an occasional cruise. His wife and he "made it for over 45 years, until she passed away last July. Now all I have is weekday golf and an occasional cruise."

From Emily Cree we learn the sad news that her husband and our classmate **John Gordon Cree** died on November 14, 1981. He was manager of utilities of the Borough of Chambersburg, Pa., for more than 25 years. He was so active in so many local activities that he was called "Mr. Chambersburg." He leaves his wife, a son, a daughter, a sister, and five grandchildren. . . . We are sorry to hear that **Frederick L. Mahoney** died on January 1, 1982. To Florence Mahoney and family our class sends our sympathy. . . . **Philip T. Boothby** writes the following to us: "I have had a very simple, pleasant and rewarding life since I left you all and the Institute way back in 1932. It took me nine years to get around to getting married and settling down near Portsmouth, N.H., where I was an engineer with the Navy department. We had two lovely girls. In 1973 we retired here in the so-called 'north country.' Since then we have enjoyed ourselves, seeing the world and just being genuine retirees. Sure sounds simple but a great deal happened during those years, and I would be most happy to go back and do it all—every bit—again." Hope to see you, Phil, at our 50th.

Adolph Warsher sent us the sad news that his close friend and our classmate **Edward Richmond Levine** died on December 17, 1981. He is survived by his wife and two children. . . . **Hugh Kelsea Moore**'s wife, Margaret, informs us that Hugh died on April 9, 1981. May I express the class sympathy and condolences to you, Margaret.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

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A lot of my material this time is Christmas in nature, like late arriving cards. **George Stoll** announces that the Conservation Commission, rebuilding tractors and other things, keeps him busy, on the hop. (Please understand that I am merely copying!!) . . . **Westy Westaway** comes through with a pretty card but no usable message other than "howdy." . . . Another, just great to receive, is from Fran and **Colonel Newton**. Newt says that he is hanging in there just waiting for the 50th, taking it real easy to watch out for an unfavorable heart bit. You will make it okay, son, just as I hope to—as I, too, must watch out for my own ticker. . . . **Bill Baur** writes, via card, that he and Helen took a trip into the Pacific Northwest and the Canadian Rockies. He visited with **Gus Liljigren** (the tall Swede) who moved west some years back, and is now retired there. Bill and Helen returned to Florida via a short stay on Cape Cod. . . . Our own **Werner Bachli** does not fool around. He and Jeanette, plus daughter Heidi, sent us a family letter. My report is shortened because of our usual lack of space. Heidi made the dean's list at Providence College at the end of her third year. Werner again attended the Appalachian Club camp held this year in Stratton, Maine, and he managed to injure a tendon in his left thumb while wringing out a pair of sox. He elected not to fix the tendon via surgery, though surgery was indicated.Many thanks, Werner. It is nice to know that you are otherwise well. . . . We have a fine card from Lucy and **George Henning**, not the big montage of family photos as of yore but a lovely, quite sentimental card with two photos, no doubt taken at the Henning retirement home at Hobe Sound, Fla. Both photos show the ocean as background, one of Lucy and George enjoying the cool breeze. . . . We have **Harry Summer**'s usual fine Christmas greetings from Evanston, Ill. Harry retired by going to work for the video division of Bell and Howell. Golly, he must be real young looking. They have done some traveling, exploring both U.S. coasts, as well as a trip to Italy. . . . Doris and **Len Julian** come through with a full page about their family situation. They spent their last winter vacation in Florida, then the summer on Cape Cod. This year the Julians are contemplating a sabbatical from their adult education activities. With such a large family, scattered all over, it is small wonder that they both are thinking retirement.

A letter from Jermain and **Jack Andrews** says Jack is retired from the New Jersey Department of Transporation but is still carrying on as a consultant. Jack appears none too happy in this consulting part. Consulting is a profession in itself, and I also found that I was not happy with it.Jack and Jermain, however, have a little something on the rest of us—their ability and interest in tennis and skating. Those two items take care of the year around. I do hope that they were able to visit daughter Valerie and husband at Sanibel, Fla., for the Christmas holidays. Jack sort of promises to keep the faith in the 1933 class news department. Many thanks, friend.

We have a small mention of the **Ralph E. Cross** Lectureship, which aludes to the first three lectures to start in January. It is mid February as I write, so perhaps we will have more details later. . . . **Dick Fossett** writes to say he and Charalee are looking forward to the 50th in June 1983. This summer they plan to visit Switzerland for extensive hiking in the Alps. Then they look ahead to winter skiing. This bit that follows is, to me, real news. "Our three children are successfully occupied away from Garden Grove but visit frequently. We have five grandchildren, all still in school. We do some work with the Educational Council and in our church." I, personally, did not know that the Fossetts had any children.Many thanks, folks, for your fine letter. . . . We have a short note from Dr. **William Harper**, who gathers that I have joined a rest home. Not so—I have bought into a deluxe retirement home. There is a vast difference, you may be sure. I occupy a two bedroom apartment, complete with living room, two baths, and a small kitchen. I do no cooking. Friend Bill, I have every intention of attending the 50th, always having in mind that I have to live that long in order to make it. Now, I expect you to be there, too, and I know you will. . . . Louise and **Ellery Clark** report on one of the longest trips I have heard of in some years. In the fall of 1981 they took off for the British Isles. They visited Ireland first, as well they might, I'll have you know. They kissed the Blarney Stone, though they say this did little good. So, what did you expect? In Dublin they ran into Louise's counsin Hazel and/or Gil Stafford. Which one was the cousin? Anyway, they had lunch together and spent the afternoon with them. Louise and Ellery also covered England, the land of their ancestors, then visited Wales and Scotland (the land of my ancestors, traced to the battle of Bannockburn. I never did find out how they had such a great battle in or near a brook [burn]).Then, they spent a full week in London and did not get lost, ever—quite a feat! They then sailed on the *Golden Odyssey* to the eastern section of the Mediterranean, and saw more ruins than they thought existed. Ephesus in Turkey proved to be the most interesting, with its marble streets, fine statuary, stadium, and condominiums. Next stop was Egypt. They visited the King Tut exhibits, the pyramids, and rode on camels. (Sure, I shoulda seen you.) They also visited Israel, Golan Heights, then on to Bethlehem and Jerusalem. The Greek Islands seems to have impressed them, what with whitewashed houses. The trip ends here, but I would like to know how you got home. I must agree that it sure was a great trip.

I wish to thank all the above contributors of cards, notes, and letters. One more remark regarding Christmas family letters. Due to our lack of space, I have to omit a lot of prose, to my regret. May I mention that the Alumni Association will, in time, tell you all how the red jackets are ordered for our neophyte 50-year fellas. I wish you all that is good.—**Warren J. Henderson**, Secretary, P.O. Box H, Exeter, NH 03833

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This month I benefit from our classmates' generosity, which has brought a bumper crop of Alumni Fund notes. And they have come from the ranges between the West Coast and Mexico. Several times we have had news from **Jerry Raphael**, who has combined a career in teaching, designing reinforced concrete structures, and boating (literally, if you will remember). He writes: "Now 'retired' (?) but it seems to mean I've only stopped teaching at the University of California at Berkeley. I'm working on another Boulder Dam in Honduras—called El Cajon Dam—same shape canyon, a little higher, and THIN! Learned Spanish to help my four-times-a-year visits to the site. Still sailing *Sprite* when not at sea on cruises. Went with the M.I.T. (Quarter Century Club) trip on *Sea Cloud* last February. Fabulous!" . . . Also from the West Coast, **Carroll Fentress** says: "Retired 1976, moved to Oregon June 1979 to 'live with grandchildren.' Built a new home. Busy! University courses, civic associations, etc." This is really quite a move. If I remember correctly, Carroll came to Tech from

Richmond, Va. Well, maybe he's living in southern Oregon. But it is nice to see in this day of talk about "extended families" that at least some children will really get to know their grandparents.

Problems seem to lie behind **Eugene F. Magenau**'s comments: "When you convert a summer cottage into a year-round home entirely on a do-it-yourself basis, it never gets finished. Current project is a passive solar domestic hot water heater. Progress would have been a lot faster except for summer interruptions to play tennis and winter delays to do some consulting in California. Sounds a little like the old saying—"Work doesn't bother me, I can sit and look at it all day long!" . . . **Eino A. Jaskelainen** writes, "Retired from Eastman Kodak Co. in 1977 as a development engineer. Spend three-and-one-half months in the winter in Sanibel, Fla., which includes two week tours in the Caribbean and Central American countries. Summers are spent in Pittsford, N.Y. During the fall seasons, I've been studying medicine at the local community college." . . .**Ruth P. MacFarland** notes, "We're living in Connecticut after many years in Ohio. We spend our winters in Florida, this year in Venice. Our street is The Rialto. I would love to hear from anyone who also might be in our area."

Now to south of the border. **Rodolfo Gonzalez Garza**, who lives in Monterrey, writes: "I have just met in Quito, Ecuador, two of my fraternity brothers of Phi Lamba Alpha—Antonio de la Torre, '31, and Nicolas Velez, '32. We had a wonderful time remembering our life in Boston while we attended M.I.T. and have plans to have a reunion with three or four other brothers in Monterrey next year. It was a wonderful experience after 50 years." . . . **Ed Sieminski** sends some word of his present life: "Retired and in good health, largely due to the new ortho-molecular approach to medicine. Living half-and-half in New York City and in Massachusetts, the 'old homestead.' Once in a while in Los Angeles with our son's family (the 'new homestead'). Continuing hobbies of ice skating, economic studies, and survival philosophy." I'm not quite sure what Ed means by that last one—all I can think of is George Burns' gag about how every morning he gets the paper, reads the obituaries, and if he doesn't see his name, he gets up and shaves!

John Newbegin writes: "Finally joined the society of seven-day weekends. Expect to spend about six months here in Pa. (Easton?) and six months at our home on Lake Champlain, where I have a lot of finishing to do." . . . Two who are still active professionally, at least to a degree, are **Albert Schulerud** and **Aldo Miniotto**. Al says, "I am continuing my part-time consulting of soap-making processes. This has taken me to Haiti, the Dominican Republic, and Argentina in 1981. I fill in my spare time with singing, gardening (mostly vegetables), and golf and bowling." Aldo notes, "I am a practicing architect doing religious, commercial, and industrial work.I winter in Florida and do research on Egyptian and Mayan art."

My final Fund note is on a more somber tone. It is from **Irving Kusinitz**, who writes: "For a long time I have been trying to get up the courage to write and tell you that I lost my dear wife Rose on December 13, 1980. We had been married for 44 years and it certainly is the same as losing a vital part of oneself. We had been planning for my retirement at the end of February 1981, but I extended it to October 31, 1981. So as of now I have been retired two months. I'm still working on a consulting basis and will be in Mexico City for a week in January. There is also a week being firmed up at our plant in England during February (what weather he ran into then!) so I guess I'll still keep my hand in." It's hard for those of us who have not suffered a loss like Irv's to say much that is very meaningful. But I know of some others in the class who are in the same position and regularly I have to list wives who have the same ache from losing one of our classmates. Our sympathies are equally sincere in each case.

Ironically, I have to pass on news of one of the latter cases with the death on December 3, 1981, of **Thomas F. Donlan, Jr.** He was retired from the shipbuilding part of Bethlehem Steel Co. In 1962 he had been named project officer for nuclear attack submarines and was sent to San Pedro, Calif., where he was also a hull constructor on two guided-missile destroyers and in the completion of cargo ships of the American Mail Steamship Line. On his return to Massachusetts, he worked at General Dynamics and the Hingham shipyard as a hull supervisor. Tom is survived by his wife Elizabeth, a son, three daughters, a sister and brother, and 10 grandchildren. As I mentioned, we can only extend our sympathy and condolences to his family.

The notes about **Bill Baker**'s death brought a letter from **"Stead" Wright** who had been a fraternity brother and good friend of Bill's when they were in school. He comments, "As for ourselves, Dorothy and I manage to keep going along. She keeps busy with her History Club, and I still bowl three days a week. I've had to cut back on golf due to back and leg problems which, fortunately, do not affect bowling too much. Last spring we took a six week's drive through the 'four corner states' of New Mexico, Arizona, Utah, and Colorado—from 108 degrees F and 2 percent humidity in the Sonora Desert of Arizona to snow drifts and watching skiing at Monarch Pass in Colorado. The trip was broken by visits with friends in Albuquerque, relatives in Yuma, and stays in Green Valley, Ariz., and Denver. It was good to get home—too long a time to be living out of suitcases. The various inconveniences soon wore off and we took our usual four-week fall trip to Harwichport, Scarsdale, and Silver Springs, Md. Our first snow and hard freeze of the season was on November 22, and it is now time to think of deserting Wheaton, Ill., for warmer 'climes.' We'll start by spending the Christmas holidays with friends in Hot Springs Village, Ark.—a really beautiful spot."

George Bull has also been traveling and writes: "Having heard how interesting and spectacular the Copper Canyon section of the Sierra Madre in northwest Mexico is, we decided to take advantage of a Department of Agriculture Travel Club trip there. Maureen and **Art Manson** were also interested, as were friends from the Class of '35, John and Betty Best. We all met in El Paso and drove to Chihuahua, which turned out to be a large and very attractive city, surprisingly cold due to its altitude. We took the train to a place called Creel, where we stayed two nights. We went down a long, winding road to the bottom of the canyon. On the way back we had a flat tire in pitch darkness. Fortunately, a lady in the party had a flashlight. The next day we had a very spectacular train ride through fantastically eroded rocks and to one place where the train stopped to allow a view that was really reminiscent of the Grand Canyon without the red coloring of Arizona. After arriving at the town of Los Mochos and spending a night there, we drove down the coast to Mazatlan where we enjoyed a fine hotel and swimming in the Pacific. Art Manson tells me that they are drilling for oil around his several acre second home in Gonzales and that he has signed a drilling lease. Some day we may have an 'oil baron' among our class members!"

I was happy to get a letter from **Richard Bell**. He said that he had the privilege of attending the first annual reception and dinner of M.I.T.'s Sustaining Fellows which was handled with Tech's usual impeccable taste, and that Bill Bates, '35, a retiree from U.S. Steel has joined his company, Bell Research, Inc., Chester, W. Va. He is anticipating a long and fruitful association. Dick went on to say: "My health continues good and I am as active as ever, among other things doing overseas consulting on mining for the U.N., Department of State, and the International Executive Service Corps." . . . It begins to look as though 1982 will finally be the year the Franklins' luck changes. I've been interested for some time in trying one of the inexpensive trips advertised through the Quarter Century Club. So late in January we went to Martinique for seven days. Getting going was a bit of a problem—I gave the security people fits by tripping the magnetic security detector. It was the wires in my chest from last year's heart surgery, but they didn't have a hand monitor and finally gave me a half-hearted, apologetic frisk! Then we were three hours late taking off—the plane had been sitting out in zero weather, the lavatories were frozen and had to be thawed, and some of the water pipes had burst. We landed at Martinique in a downpour. It wasn't the rainy season (so they said), but we had off-and-on "liquid sunshine" every day. But it was an enjoyable trip. By the time these notes appear we will be in Europe to finish (and then some) the trip that was interrupted in 1980 and then had to be put off for 1981 because of my by-pass operation. Things seem fine now—my only annoyance is the winter weather that has kept me from my daily walks.—**Robert M. Franklin**, Secretary, 620 Satucket Rd., (P.O. Box 1147), Brewster, MA 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20015

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Here are some messages by way of the Alumni Fund office.From **Robert Olsen**: "Retired in 1977 and spent the next four years working with migrant farmworkers at a Immokalee, Fla., home that sheltered eight to ten thousand of them in the winter. They work very hard picking fresh fruits and vegetables. Eighty percent are below the poverty level, live in miserable shacks. Amy and I founded Immokalee Funds for Humanity to build homes to be sold at cost, with no interest payments, to such unfortunates. We built eight, hope to do more. No government funds are used. In May 1980 we retired again. Now I am blazing a new hiking trail, 60 miles long, to connect a 120-mile trail in central Pennsylvania with the Appalachian Trail. Any hikers in the Class of '35? Oh yes, **Allan Mowatt** says we will put a crew on the Charles in 1985. I'm ready. Can we get six more?" I'm sure we can, and more. . . . From **Don Gutleben**, "Have been happily retired from the sugar business for about eight years here in Alamo (30 miles east of San Francisco) in our 30-year-old home on half an acre.Keep fully occupied with gardening, swimming, golf, traveling and selling a house now and then as a real estate broker. Hope to make the 50th Reunion." . . . From **Willard F. Bixby** (I'm sure he'll row), "I retired in 1978 after 42 years with the B.F. Goodrich Co. I now follow a busy schedule as consultant to my former company and others, specializing in the field of process design, materials selection and corrosion control, and environmental emissions control."

Here is a note from **Jack Holley**, "Hi classmates: Ole Gramp got in early this year—taxes. My plans to return to school this year materialized, somewhat. I'm taking welding. This is a hobby. Old men should have hobbies.(Women should

have hobbies too. I believe they prefer generous hobbies.) This is the *right place!* Come to the great Southwest, retirementland for the cognoscenti. In San Diego, you can grow tasty bananas in your backyard. The banana thrives on our adobe. Besides our adobe, we are noted for earthquakes, volcanoes, and flakes. My health is good and this permits me considerable activity, like involvement with retirement groups, politics, volunteer work at the library, etc. My advice to the class is: Stay young at heart."

Our class was represented in the Alumni Fund's fall telethon by **Phoenix Dangel**, our class coordinator, and **Randy Antonsen**, **Ben Blocker**, **Dave Terwilliger** and your secretary. The spring telethon comes May 10-13. . . . **Bernie Nelson** has been talking to many of us in the Boston area and other places about running a series of "dutch treat" mini reunions in different cities during 1982. It sounds like a good idea, and as Bernie explains, it could be in the form of a lunch, cocktail party, dinner, or picnic with spouses. The purpose is to renew friendships with classmates and receive some suggestions for our 50th in 1985. He has written to all our Regional V.P.'s asking for comments and suggestions on how they would plan for their area. While it is still early to hear from them, he has had notes from **Goffe Benson**, **Phil Johnston**, and **Ed Taubman**, who, by the way, is thinking about having a cookout for classmates from the Baltimore and Washington areas and Virginia this summer. **Ned Collins** is thinking about a class dinner in the fall for those around Boston.Remember we are almost halfway between that grand 45th Reunion at M.I.T. and Wianno and our 50th. Hold open June 6-10 in 1985. Bernie and Rhoda spent the month of March in Texas visiting their children and friends.

Charles Debes wrote from Key West and gave some interesting details about the mini-stroke he had in September. He credits the fact that he was in one of his nursing homes, surrounded by experienced nurses, for his quick recovery. His advice: If you must have a stroke, get to a hospital PDQ. A proprietary hospital group has approached him to plan, design, and construct a hospital, nursing home, and medical arts building on a portion of an 11-acre tract on U.S. 1 on the Gulf. "So, after talking with contractors, engineers, architects, and construciton managers, I'm not sure whether I am on a vacation or not. I do know I'm not ready for retirement."

We are very sorry to learn that **Charles Piper** lost his wife about six months ago. He has all our sympathy and condolences.

Thank you for your letters and notes. Keep them coming.—**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, MA 02160

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First, the sad news: **Norman Bull** died on December 20, 1981, after a long bout with cancer. He was employed in Neenah, Wis., by Kimberly-Clark Corp. in sales management and had been with the company since 1940. He is survived by his wife, Adelaide, two daughters, and a son. . . . **Roger LeBlanc** died on December 17, 1981, in Manchester, N.H., after a long period of incapacity. His widow, Marjorie, lives at 117 Clarke St. (03104).

On a happier note, Maxine (Mrs. **Milton**) **Dobrin** reports that the scholarship fund established at the University of Houston honoring Milton has chosen its first scholar, an Indian working on his master's in geophysics. In addition the university is establishing a Milton B. Dobrin chair in exploration geophysics. . . . Ruth and **Hank Lippitt** sent their customary newsy year-end bulletin—and my how they do get around! In addition, they passed on a Christmas letter from **Claxton Monro**. Last May, after 30 years as rector of St. Stephen's Church in Houston, Clax retired, and he and Vicki moved to their *first* home in Austin, Tex. (4702 Red Stone Ct., 78735). He continues as a supply rector in the area and is working on a book, so he is pleased to have a seminary library available. . . . Carol Saylor writes from Cape Cod that husband **Bill (William R.) Saylor** has become deeply involved in plant hybridizing and has received a silver medal from the Massachusetts Horticultural Society for his work.

W. Boynton (Slim) Beckwith reports from San Diego that his meteorological consulting business took off expectedly last fall. He says it is "gratifying to know that 70-year-olds can still be useful in their fields as expert witnesses before judge and jury, and put a damper on some who would reinvent the wheel.' " He is rejoicing in the birth of a grandson to carry on the Beckwith name. . . . **Aaron Loomis** is as busy as ever making beautiful, sturdy wooden toys. He has had trouble keeping his business down to a one-man operation, the products are so in demand. His testing team includes his eight grandchildren and his wife's first grade class in Marshfield, Mass., where the Loomises make their home. . . . **Baxter Moore** has retired to Maine after 20 years in Ohio with NCR. He keeps busy consulting on a fairly regular basis.

Wilfred (Wiley) Post has received yet another honor. This time it is his selection as a distinguished Pennsylvanian by the William Penn Committee. . . . **Martin Gilman** notes nothing new to report, but I happen to know he keeps very busy with volunteer activities. . . . **Raymond Woodrow** retired as senior university officer at Princeton and is the author of a book, *Management for Research in U.S. Universities*. . . . **Hamilton Migel** writes that he is back playing tennis after bypass surgery over a year ago. Living in Charlestown, R.I., makes enjoyment of boats and the ocean easy. . . . Well, I personally am heading in the other direction, as I am writing on the eve of a camping trip to Big Bend and Guadalupe Mountains National Parks in Texas with my daughter Martha.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

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Robert G. Clancy, Jr. of 41 Grandview Ave., White Plains, NY 10605, writes that he is enjoying his retirement from A.T.T. Long Lines and spends summers in Meredith, N.H. and winters in White Plains. Their daughter Carol was promoted to lieutenant colonel in the Air Force and was able to spend Christmas with them. . . . **Frank D. Lewis** of 15 Woodland Rd., Lexington, MA 02173, at age 70 is still working half time as chief engineer at Caywood in Malden, Mass. His son Peter, '75, and grad student at Yale, and his wife Eileen have presented the first grandchild, Rebecca Joy. . . . **O. William Muckenhirn** of 2341 W. Grecourt Dr., Toledo, OH 43615, writes that he was "awarded emeritus rank in June 1981 but will continue to teach fall quarters on University of Toledo's early retirement. Will spend January and February in Largo, Fla." . . . **Robert P. Rudy** of 160 Riverside Dr., New York, NY 10024, writes, "Joan and I are keeping busy and active in the business—no retirement in sight. We had some health problems this year and hope next year is much better. Visits with the children and grandchildren are welcome interludes. We also travel occasionally, in and out of the country. We are looking forward to the 45th." Some other interesting news in regard to Joan and Bob—the M.I.T. museum presented a fascinating and very exciting exhibition of the Forbes whaling collection of prints and paintings. In conjunction, and as part of the whaling scene, they selected for simultaneous display a very choice and diverse group of pieces from the Joan and Robert Rudy Scrimshaw Collection. The exhibition was from February 11 to April 17 in the Compton Gallery, Building 10-150. . . . **Willard Marcy** of 3 Priory Ln., Pelham, NY 10803, vice-president for invention administration of the Research Corp., New York City, has been named president-elect of the American Institute of Chemists (AIC) for 1981-82. He joined the Research Corp. in 1964 and before that worked for the Amstar Corp. (formerly American Sugar Co.). He has been actively engaged in AIC activities for the past several years, and from 1979-81 was a member of its board of directors. In addition he served as chairman of the New York chapter and headed two national committees on ethics and on qualifications and admissions. He was also a member of the editorial board for its serial publication, *The Chemist*. Dr. Marcy also has been extensively involved in professional society work for the American Chemical Society where he chaired its committee on patents. In addition, he has been a member of the American Association for the Advancement of Science, the Chemist's Club of New York, the Institute of Food Technologists, the New York Academy of Sciences, and the Society of Chemical Industry. He serves on advisory panels for the National Science Foundation and the Office of Technology Assessment.

It is with deep regret that I report the death of **Albrecht Edward Reinhardt** on December 7, 1981. His last address was 1269 No. Main St., W. Hartford, CN 06117. Al worked as a mechnaical engineer at Hamilton Standard Division of United Technology Corp., retiring in 1979. He was a life member of the American Society of Mechanical Engineers and the holder of several patents. He leaves his wife, Claire (Eliot) Burton, and two daughters, Dr. Drew Reinhardt of Iowa City and Shelly Reinhardt of Brooklyn, N.Y.—**Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

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If you tried to radio **Cliff Nelson** as a result of class notes several months ago, the fact is that my typewriter blew it. The typeface is a script, and "I" looks like "J". Cliff's correct call is W1IDA.

We are becoming quite a retiring class: **Livingston Smith** retired as vice-president of Stone and Webster Engineering. . . . **Norman Stewart**, after 34 years with Heald Machine Co., turned in the keys to the executive washroom. . . . **Howie Milius** retired from Millmaster Onyx and is now studying drawing. . . . Lastly, **Donald Barnaby**, also retired, occupies himself with the electronic organ and tends his bonsai collection. . . . **Korky Kaulakis** apparently has partially retired—he is no longer chief executive officer of Pittston Petroleum Co. but continues as chairman.

What with retirement, I receive more news of peripatetic classmates. Roberta and **Horace Homer** recently returned from a fascinating trip to Peru, and, of course, Machu Picchu.

Meanwhile, back at Cape Cod: **Dave Wadleigh** was just elected vice-president of the liveliest Tech alumni club—the M.I.T. Club of Cape Cod.

Last minute reminder: if you haven't signed up and can make it, our class dinner is scheduled for the evening of June 11 at M.I.T.'s Endicott House in Dedham.—**Armand L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

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Burns Magruder came to San Diego to represent duPont and, through his activities on some national committees, has made the world a safer and better place by having better valves in its chemical and petroleum plants. To make this trip, he had to tear himself away from the unseasonal New Year's blizzards on the East Coast and his four-times-per-week indoor tennis matches at Wilmington. Classmates who see Burns these days can admire what tennis has done for him. To thin down and convert our teepee-shaped silhouettes back to V-shape, we could copy his strategies. Burns and I had lunch overlooking the harbor to inspect part of the Navy at anchor. Then we drove up the coast to inspect the Torrey Pines Golf Course before the start of the Andy Williams Open. All of this to say that the southwestern corner of the U.S.A. is a nice place to improve valves, meet and reminisce with classmtes, or just enjoy fun and relaxation.

Wes Kuhrt retired as senior vice-president, technology, of United Technologies Corp. after 42 years' service and after having earned brilliant career honors. . . . **Fred Schaller** and **Seymour Sheinkoph** were active in the upgrading telethon for the Alumni Fund last autumn. If they phone you before this summer, it's because the Institute needs financial help and because you have been complimented by their invitation to re-examine the above-average affluence that M.I.T. helped each of us earn. . . . **Seigbert Oettinger** retired from the Pittsburgh Des Moines Corp. and expects to consult and travel.

We were saddened by news of the death, at Sun City, Ariz., of **Arthur Grossman**. There were no details.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

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A mini-Reunion in Cambridge has been planned for Thursday and Friday, June 10 and 11. **Norm Klivans** and **Ed Bernard** have carried the ball for this event, with Ed doing most of the "leg work." Notices were sent out in March to all class members. However, if you have misplaced yours and want to attend, write or call Ed. His address is 57 Winn St., Belmont, MA 02178, (617) 484-8598.

Received an interesting letter from **Al Guttag**. He is now the second oldest member of his law firm—Cushman, Darby, and Cushman. The oldest member is Daniel Varner, '36. The firm is the largest patent law firm in Washington, D.C., and one of the three largest in the country. Al joined one of his sons, Karl, in the Houston-Tenneco Marathon on January 24. They both finished. How many of us could run this distance these days, or still average 2,200 to 2,300 miles a year, as Al has since 1976?

One of our most illustrious graduates is **Ieoh Ming Pei**, who has been described as "a Chinese Metternich" by author-architect Peter Blake. The comparison is to the Austrian diplomat whose talents made him the architect of political power in post-Napoleonic Europe. Pei and his I.M. Pei and Partners have won many awards, including the American Institute of Architects' highest honor, the Gold Medal. His most recent buildings include the John F. Kennedy Library, the Nestle corporate headquarters in Purchase, N.Y., Dallas City Hall, the West Wing of the Museum of Fine Arts in Boston, and the East Building of the National Gallery in Washington. His most recent challenge was the hotel he designed outside of Peking, which will open this summer. The hotel marks Pei's long-awaited return home.

A number of classmates are retiring. They include **Joseph H. Greenberg** who has retired from A. T. Kearney, Inc. but continues as a consultant to the firm. He is also teaching evening courses at the Illinois Institute of Technology. . . . **Raymond E. Keyes** has retired from Westinghouse Hanford Co., where he was the design engineer for a group of reactor core test assemblies. He is now doing documentation for a contract for the Washington Public Power Supply reactor power plant No.2. . . . **Leonard W. Weaver** retired in April from Bird and Son, Inc., after 41 years. He is also retiring as director of the Neponset Choral Society after 33 years. He missed the December performance of Verdi's "Requiem" because of a heart attack, but is now improving. I caught the performance, which was outstanding, and was sorry to miss you, Leonard. . . . Other retirees write that they are traveling, fishing, writing, involved in local civic affairs, and just plain doing "nothing." They include **Joseph L. Mahoney**, **Abe Rockwood**, and **E. D. Crosby**.

Please drop me a line and let me know what you are doing.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

42 40th Reunion

Last call—this is really the last reminder—get your reservations in NOW for our 40th Reunion on campus and at the Wychmere Harbor Club on the Cape. **Bob Howard** and **Carl Zeitz** say the program is super. Don't miss it. As an extra bonus, we're putting out a hardbound book of all the class notes from our 25th Reunion (1967) to our 40th.It will be complete with an index listing the issues in which your own news was noted, so each of you can re-read, and have a permanent record of all those "gems" you sent in during the past 15 years!

Have finally found the classmate who has the "dream" job.**Bob Imsande** writes that he has been with Anheuser-Busch Companies, Inc. in St. Louis for the past 15 years, most recently as director of Environmental Engineering and Resources. How would you like to get all that free beer? . . . **Bob "Hawk" Shaw** is busy helping the Southern New Hampshire M.I.T. Club get on its feet in addition to keeping his farm solvent and his work as medical examiner. Sounds as though he plans to be with us at reunion time but asks if his newly acquired doberman pinscher will be welcome at Wychmere. "Hawk," of course the answer is "yes." The dog can sleep with Bob and Carl.

Warren Loud will miss the reunion—he is on sabbatical in Italy until August. He's been in Florence and will be in Trento from March on. Warren is still in the mathematics department of the University of Minnesota (when he's working!). The Louds' previous sabbatical was in Japan where Warren was a visiting professor at the University of Kyoto. . . . **Alan MacNee** has just returned to the electrical engineering department at the University of Michigan from his sabbatical year at the Los Alamos Laboratory in Albuquerque. While there, Alan visited with Kay and **Bob Osborne**. Bob, Course VIII, has recently retired from Los Alamos. . . . **Sandy Peek** reports he has completed a five-year stint of venture development in GTE's new electronic industrial control business. His chores were evidently successful because the business is now an operating group. Sandy says that he is now trying to figure out what to start next.

Congrats to **Karl Wenk**, recently elected a director of the Provident National Bank in Philadelphia.



Karl Wenk, '42

He joined Provident as executive vice-president in 1977, and has been in the consumer finance industry for about 25 years. He is active in the Pennsylvania Bankers Association and is a director of the Old Philadelphia Development Corp. and the Pennsylvania Economy League. . . . Please take note of a request from **Nanu Amin**, chairman of Jyoti, Ltd. in Baroda, India. He has established a community science center in Vadodara. Its object is to promote a "scientific and technologic temper and a spirit of inquiry in the community." India's schools and community centers have very little in the way of books, magazines, articles, educational toys, and exhibits. Our discarded materials can be very useful. Do write to Nanu at: Joyti, Ltd., Baroda, India 390-003. He will be glad to send you more information and a list of the kinds of items that would be useful.India's customs regulations are (to quote Nanu) "somewhat peculiar," so he will get government permission to bring the materials into India.

Ed Wise retired from Union Carbide last November with almost 36 years of service. His specialty was research in polymer and organic chemical synthesis and phase studies.The Wises are now living in a townhouse in the Jamestown subdivision. . . . A fancy news release from Bethlehem Steel tells of the retirement of **Jack Briggs** as vice-president of planning. Jack has been with Bethlehem since graduation, with two years out in military service. He headed the planning department since its establishment in 1967.

With sadness we have three obits this issue: **Ernie Artz**, **Russ Estelle**, and **Fred Klerker**. Ernie was with Olin Chemical in Philadelphia, Russ had retired as manager of engineering at Gamon-Calmet Industries in Florence, Ky., and Fred had been with Smith Courtney Co. in Richmond, Va.We extend most sincere condolences to their wives and families.

Looking forward to seeing you all at our reunion.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

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Big **Bill Thurston** rides again, this time into the chairmanship of the 1,800-member company, American Electronics Association. He will lead the AEA in 1982 as it gives top priority to the shortage of technically trained people and to unnecessary restrictions in U.S. export policy. Bill is president and CEO of GenRad, Inc., Concord, Mass.

John Linvill is a co-director of Stanford University's new Center for Integrated Systems. With a number of industrial sponsors and contracts from the Department of Defense, the Center merges the interests of the university, industry, and government. It will be training graduates and conducting research in most aspects of the electronic revolution, from silicon chips to computer software.

Bill Voorhis retired from General Instruments in 1980 and now lives on a lakeshore near Enfield, N.H. He enjoys the company of his wife Ruth and the more distant existence of four stepgrandchildren. His primary concern, however, is fishing, although he might pause long enough to attend the 40th Reunion.

Jim Malloch and wife Sue now live in the San Francisco Bay area at Hillsborough. They have four children, but no grandchildren at this point. Jim is occupied with a phosphate plant project for Chevron Chemical, but finds time for golfing and skiing. He reports seeing Ralph Leader, who is also on the West Coast with Standard Oil of California.

A number of classmates participated in the Alumni Fund's fall telethon: **John Ward**, **Jean Hartshorne**, **Jim Hoey**, **Jim McDonough**, and **Ken Warden**. Be prepared for the spring telethon, May 10-13.

Looking ahead from the depths of February, I urge you all to enjoy the summer.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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Technology Day is scheduled for June 11 this year. If you would like to get together for dinner that evening, please let me know you are coming by June 1.

Thanks are due to **Herbert W. Cantor** and **Joseph A. Alexander** for representing our class in the Alumni Fund's fall telethon. By the time you read this, one or both or some other classmate may have called you during the spring telethon. Your gifts to the Alumni Fund count toward our 40th Reunion Gift.

This column relies heavily upon your notes added to your Alumni Fund envelopes. Your secretary greatly appreciates your time in adding to the envelope, and the class enjoys hearing about you. **Art Dershowitz** writes that he is still in corporate planning at GE. He also devotes time to working on surveys of demand for engineers for the engineering manpower commission of AAES. His vacations have taken him to Israel and the Northwest (Washington and British Columbia). His two sons and one daughter-in-law write their own M.I.T. alumni notes.

Jim Weaver says that he retired in 1980 as vice-president, Venture and Capital Appraisal, ICI Americas, Inc. He now consults as Venture Services, plays in a Dixieland band, and gets in plenty of tennis. . . . **Warren B. Delano** writes that he is chief of transportation planning for Hidroservice, where he has been for 13 years, in Sao Paulo, Brazil. He was recently transferred to the grade of fellow of the Institute of Transportation Engineers. . . . **Gerald Cauvin** notes that he is vice-president and advisor to the chairman, Thomson-Brandt, Thomson-CSF, Paris.

Walt Turner heard my plea for notes and wrote that he is professor of electrical engineering at the University of Maine in Orono and is thinking of early retirement. Daughter Barbara is living at home and teaching at a nearby daycare center. Cathy is married and is assistant editor of *Highlights* magazine for children. Son Bob and his wife are doctoral candidates in economics at M.I.T. Daughter Beth is in a master's program in marine science at Stonybrook, N.Y. And since Walt is on the Maine board of registration for professional engineers, he and Dot have been able to travel all over the U.S. . . . **Pete Matthews** is bursting with pride these days over the accomplishments of his daughter, Andrea. She is a lyric soprano and in December won first prize in Louisville, Ky., at the National Association of Teachers of Singing's annual competition. Andrea, who represented the New York region, excelled in a field of six finalist men and women selected from the winners of 13 national regional competitions. Her prize includes a full scholarship to the Graz, Austria summer program to study opera and audition for European companies. Andrea is a history major, Princeton '78, and started voice lessons her junior year. She is only 25 and can expect her voice to keep maturing for several years.

Nancy and **Norm Beecher**, Anita and **Les Brindis**, Jane and **Lou Demarkles**, **Andy Corry** and guest, Ruth and **Norm Sebell**, **Melissa Teixeira**, and Edna and **Stan Warshaw** met recently at the home of Marguerite and **Ed Ahlberg** for dinner to start the final plans for our 40th Reunion. Tech Night at the Pops will be June 7 and Alumni Day, June 8, 1984. We will have some on-campus activities and are planning to journey to a recently refurbished New England landmark following Alumni Day activities. Save the dates—mark your calendar now—and plan to attend the events scheduled for you.

See you on June 11 this year on Technology Day.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165, (617) 332-7199

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As I write this (in February), I find myself still reflecting on the 35th Reunion, most particularly on **Curt Canfield**'s speech which had me practically writhing on the floor. He was kind enough to send a five-page transcript to **Jim Goldstein** who, in turn, ran a copy for each of the 35th attendees. Jim has since extended this kindness to anyone interested in having a copy, provided you send him a stamped, self-addressed envelope. His address is: 25 Luddington Rd., West Orange, NJ 07052.

And before I forget, I want to mention the "small world" coincidence that happened just days after returning home from the 35th. We went down to a yearly Quaker meeting southwest of Taos, where I ran into **Ted Church**. Wow!Ted's lived in Albuquerque just about all his life except Navy time and has worked for Sandia Labs since graduation.Ted, a tall, distinguished, gentleman, celebrates *his 35th* wedding anniversary with his wife, Elizabeth, this July.

Got a marvelous, calligraphic Christmas card from **Larry Body** (USN, retired). I'd say he comes by the fancy printing naturally; remember his funny cartoons in *Voodoo*? Anyway, he's been toiling at Rockwell International for ten years or more, most recently in the space shuttle. (And by God, he got it to work!) Larry lives in Santa Ana with wife Ginne (address on request).They're grandparents and think it's grand indeed.

A card I *didn't* get was from **Stan Young**, telling me how he and his family are faring. Stan, who does his own industrial consulting, had a stroke a while back and has had to make adjustments in his activities. So far as I know, he still has a boat berthed on the Hudson not too far from home which is Hastings-on-Hudson. Stanley, where are you? Say "Hi Mom" to Penny.

Old swim team buddy, **Ernie Buckman**, was selected in 1981 as man-of-the-year in business by a Pittsburgh survey organization (Vectors?). He's been chairman of Oliver Realty, Inc. since 1979 and is president of the Greater Pittsburgh Board of Realtors. He is also involved in the Rotary Club, United Way, Junior Achievement, YMCA, and is on the board of directors of the Allegheny County Vocational Rehabilitation Center. Okay, Ernie, but whad'ya do in your *spare* time?

Nice piece from the *Boston Globe* (undated) about **Bill Edgerly**, who is chairman of the State Street Bank and Trust Co. Speaking at a conference of the National Alliance of Business's New England Region and the New England Council of CETA, he is interested in moving forward on training the disadvantaged as a tool in the economic development process.This "will require not only cooperation between the public and private sectors, but will require communication and cooperation within the public sector, between those responsible for training and those responsible for economic development."

A quickie from **Bob Hoffman** who tells us he's been retired for four years and has been traveling, camping, and enjoying nature. 'Nuff to turn us green with envy.—**Russell K. Dostal**, Secretary, 18837 Palm Circle, Cleveland, OH 44126

47 35th Reunion

Reunion response has been excellent; the list grows daily.If you are not on it yet, it's not too late. How can you possibly restrain yourself from coming? All that good food and fellowship spread over the countryside from the Pierce Boat House to Pops to the Museum of Fine Arts, with its new building; from Quincy Market to Salem, with its old buildings. Only **Vince Haneman** is excused (so far), not because he lives in Alaska (he's dean of the School of Engineering at the University of Alaska in Fairbanks), but because he must be in Texas at the annual meeting of the American Society of Engineering Education, of which he is immediate past president. All others who wish to be excused should make their requests in writing to Lee or Claude, stating the reason in full. We'll read your greeting at one of the class gatherings.

From *Tech Talk*: **Moshe (Moses) Arens** is the new Israeli ambassador to the United States. Says TT: "Born in Lithuania in 1925, Mr. Arens came to the U.S. with his family after the outbreak of World War II. After serving in the United States Army, and graduating from M.I.T. [Course II], he went to Israel for the 1948 war of independence and joined the underground headed by Menachem Begin, now the prime minister of Israel. Returning to the U.S., Mr. Arens studied at Caltech [obtaining a degree in aeronautical engineering] and worked for a time in the aircraft industry before returning to Israel to stay. He taught at the Technion in Haifa and became vice-president for engineering for the Israel Aircraft Industries. He served eight years as an influential member of the Israeli Parliament, rising to become chairman of the Foreign Affairs and Defense Committee."

C. F. Jenkins writes to say that he has left the National Oceanic and Atmospheric Administration, Great Lakes Environmental Research Laboratory in Ann Arbor, Mich. for a simpler address at the Naval Air Systems Command in Washington, D.C. . . . **James Kyle**, of Waterford, Conn., head of the Submarine Sonar Department of the Naval Underwater systems Center (NUSC) at New London, has received two awards in the past year. The Navy has awarded him its Superior Civilian Service Award, its second highest civilian honor, and he later received a $3,500 cash award for outstanding performance. In the citation accompanying the Navy award, Vice Admiral Earl B. Fowler, head of the Naval Sea Systems Command, cited Jim's contributions to the U.S. Sonar Team and the Mobile Sonar Technology Committee, noting that he has been instrumental in starting and monitoring several cooperative programs with U.S. allies. Jim was a member of the sonar team and a principal member of the sonar technology

committee, which monitored developments in sonar-related areas, from 1972 through 1980. He joined NUSC in 1969 after 16 years at the Submarine Signal Division of the Raytheon Corp., Portsmouth, R.I. Jim has a master's degree in electrical engineering from Northeastern, is a senior member of the IEEE, and is active in Family Service Associations at the board level. . . . **Robert Nelson**, 1414 Ticonderoga Ave., Ridgecrest, CA 93555, (716) 446-3433, is still in the same house. "The address has been changed for the convenience of the post office and the consternation of everyone else," he says. (Surprise him: find it and drop in...)

John Maxfield is dean of the Graduate School and University Research at Louisiana Tech University in Ruston, La. To quote: "From 1949-60 I worked at U.S. Naval Ordnance Test Station, China Lake, Calif., where I ended up as head of the mathematics division. From there (1960-67) I became head of the mathematics department at the University of Florida, Gainesville, Fla. Next (1967-81), I was head of the math department at Kansas State University, Manhattan, Kans. and am now. . . [see above] My wife, Margaret, is associate professor of mathematics and statistics at Louisiana Tech. We have four children—David, on the faculty at Brigham Young University, Provo, Utah, and part owner of Interact Performance Systems; Elaine, junior at the University of Texas at Austin; Nancy, sophomore at the University of California at Santa Barbara; and Dan, just completing high school. . . . I hope to see you some summer.We usually spend a month split between the farm at Beecher Falls, Vt. and our place in Baie Ste. Anne, N.B., Canada."This is the summer, John! We'll expect to see you and Margaret at the reunion!

I have received notification and must sadly report the deaths of classmates **William Heyser**, Oklahoma City, Okla.; **Kenneth Haber**, Cleveland, Ohio; **Bruce MacRae**, New Milford, N.J.; and Dean Pitre (at the age of 83). Our sympathy and warm regards go to their families.—**Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

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Don Atwood was named to the new post of vice-president and group executive in charge of General Motor's worldwide truck and bus group on November 2, 1981. In an interview with *Ward's Automotive World*, Don was quoted: "What we are attempting to do is establish ourselves in a leadership position on a worldwide basis for the design, manufacture, sale, and service of high-quality trucks and buses that meet the needs of the worldwide marketplace." Reporting directly to Don are GMC's medium and heavy-duty truck and bus, small and light-truck and van, and engineering operations, as well as Chevrolet light trucks. On a worldwide basis his group is responsible for Vauxhall Ltd.'s Bedford truck operations in England and for coordinating with Isuzu Motors, Ltd. (GM's 34.2 percent-owned Japanese partner) for the truck plant in Taiwan and others. They are studying what the future relationship with Detroit Diesel Allison Division (DDA) should be. Right now, though, Don says the relationship is "very close." Up until January 1981 Don headed DDA as vice-president and general manager.Don says ultimately his group will be a much tighter, more functionally operative, organized group. He describes how many companies, including GM, have, for the most part, established individual divisions or operations responsive to the needs of a given locale in a given country and continent. What ends up out of all that is a substantial degree of inefficiency from lack of commonallity and coordination among the various operations.



Don Atwood, '48

After graduation Don earned a master's degree at M.I.T. in electrical engineering and spent three years in M.I.T.'s research labs. At age 27 he formed his own company, Dynatrol, where he did research for companies in fields such as avionics and ballistic-missile guidance systems. He began his GM career as associate director of the AC Electronics Division in Boston. After a year as director of the labs he moved to AC's Milwaukee operation as director of sales and engineering. In 1968 he became that facility's director. In 1970 he joined GM's Detroit Diesel Allison (DDA) as manager of Indianapolis operations, moving three years later to general manager, Transportation Systems Division. Since 1974 he has held positions of general manager, Delco Electronics Division, DDA vice-president and general manager, and in January 1981 he was elected vice-president, group executive, Electrical Components Group. While at AC, he worked on guidance navigation systems for the Apollo space program and Titan missile program, and at DDA, gas turbine-engine development. All of this interfaces with his new assignment: "One of the big moves we have to make in the future is the use of high technology. That's more than just a broad term; it involves specific application of the most advanced electronics for our future products." he says. "We're looking forward to introduction of electronic fuel injection for diesel engines and electronic control of transmission," he continues. GM has gone global for good. "Anyone who feels they just want to stay in the U.S. is limiting their possibilities," Don emphasized. . . . If we can sell it overseas, good luck.Good luck to you, Don.

Bill Hart is at the same stand since 1948, now working for the third owner (Ciba-Geigy). For the first 25 years Bill was involved in the R&D area. His company manufactures color pigments. More recently, he has been responsible for various areas of technical sales and service. At present he is manager of the Technical Service Laboratory in Glens Falls, N.Y., a wonderful place to live and bring up a family. . . . **Melvin Posin**, senior vice-president of marketing at Printronix, Inc., was elected a director of the company. They manufacture computer matrix line printers. . . . **Ben Ball** was appointed to serve on the advisory committee of the Center for Energy Studies at the University of Texas at Austin. Ben is adjunct professor of management and engineering at the Sloan School of Management at M.I.T. . . . Tel and **Bob Sandman** are traveling as representatives of a trade association. Current plans include stops in India and Australia. . . . **Bob Welch**, chairman and CEO of Ludlow, Corp., expects some management changes at Ludlow as a result of its being purchased by Tyco. . . . Judy and **Graham Sterling**'s son, Arley, will be married in May 1982. . . . Rose and **Leon LaFreniere**'s son is pursuing a career in fine arts. Leon is devoting more of his own time to activities in the fine arts.

Our daughter, Amy, after three semesters of classes and labs, has begun her clinical training at Harvard Medical School. During her clerkship she is learning to identify heart sounds, breathing abnormalities, and the many other symptoms of disease. Our son, Larry, is a member of the treasury department at Pan-Am airline. Recently he has been involved in the negotiation of sale and lease-back of several aircraft. Our son, Clifford, is evaluating new business opportunities for American Airlines' Sky Chefs operations. Last year Sky Chefs acquired a chain of restaurants along the New York Thruway. My wife, Gloria, is a research assistant at Rhode Island Hospital Brown University Medical School. She is conducting studies on animal muscles from the gastro-intestinal tract to evaluate the effect of drugs on muscle response. The response of the sphincter muscle is monitored continuously with a force transducer and strip chart recorder. Her boss designed and built a muscle bath that provides oxygen and other nutrients to the muscle in three-milliliter volume. This volume is much smaller than was previously available in a muscle bath and allows the use of reduced quantities of hard-to-obtain or expensive drugs.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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It's a pleasure to see the following classmates active in alumni affairs: **Michael M. Koerner** on the Committee on Nominations for Corporation Visiting Committees; **Frank F. Carroll** on the National Selection Committee; and **Anatol Bigus** on the Alumni Telethon. . . . **Fred Reusswig**, by now, should be five times a grandfather and is anticipating retirement within three years. Fred has been re-elected to Stanley Consultants' Board of Directors. . . . "Yellow dust blowing from the Gobi across the Inner Sea" is one of life's travails that Bette and **Pete Noss** must no longer endure. With five years in Korea behind them, they now live in Arroyo Grande. Pete is with Union Oil in their Santa Maria refinery. . . . **Dave Israel** is deputy director for planning and systems integration at the Defense Communicaitons Agency. He is responsible for architectural and system engineering studies for a number of command, control, and communitations systems of the Department of Defense.

John Knowlton has retired from Exxon. . . . **Austin Marx** is manager, corporate planning, at Hewlett-Packard, active in several community organizations, and plays trombone in the Tranios Woods Community Marching Band. . . . **Robert H. Ruth** has been with RCA Camden for five years after 27 years with Philco. . . . **Ross O. Watson** has been elected corporate controller of Hercules, Inc.—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017

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Richard H. Johnson has left General Motors to become a product manager of medium and large programmable controllers at Numa-Logic division of Westinghouse Electric. . . . **Richard H. Koening** retired as a colonel from the U.S. Army in February 1981 and is now residing in El Paso, Tex. . . . **Will F. Nicholson** was recently named a director of the Public Service Co. of Colorado. He has been president of Colorado National Bankshares, Inc. since 1975. . . . **Alan G. Bates** decided to take early retirement from ICI American in March 1982. Alan was vice-president and general manager of the agricultural chemicals division. A new career

will follow, which could be anything from a senior position in another company to selling antique woodworking tools. He says it's nice to have that kind of choice. . . . **Dimitrios G. Dimitriou** is still running his detergent business in Sharjah, United Arab Emirates, and also his many businesses in Cyprus. He left Cyprus in 1974 and is now living in the U.A.E. Since 1981 he has been semi-retired, spending three months (April, May, June) and three months (October, November, December) at his new home in Palm Coast, Fla. By 1985 Dimitrios tells us that he should be a proud U.S. citizen.

Our class was represented in the Alumni Fund's fall telethon by **Margaret T. Coleman** and **Lindsay Russell**. Remember that the spring telethon is coming up soon—May 10-13. Our class telethon coordinator is **Robert Cesari**.—**John T. McKenna**, Secretary, 1 Emerson Place, Apt. 11H, Boston, MA 02114

52 30th Reunion

Stan Sydney, who has long been treasurer of the Class of 1952, contributes the following two news items for this month's column. **Werner Kahn**, wrote from Rio de Janeiro, Brazil, in January. Werner has been with Gulf Oil for 25 years where he functions as sort of a South American representative in the "downstream" area (refining and marketing). Werner also travels a great deal by air throughout South America, Central America, and the Caribbean, and visits Houston between three and six times a year; but he seldom comes furthur north. Between 1964-1974, Werner was assigned to a number of positions abroad including Pittsburgh and Brussels, but returned to Rio. During that decade he was at M.I.T. once for an energy seminar in 1971. Werner writes that he sees **Luis Capandeguy** who has been living in Montevideo ever since his graduation. Luis is a consulting mechanical engineer. Werner has also seen **Julio Franzini**, an electrical engineering graduate, who has recently been president of the M.I.T. Club of Montevideo. In the U.S. Werner often sees **Bill Vogt**, a very successful patent lawyer on Park Avenue in New York City as a partner of Watson, Leavenworth, Kelton and Taggart. . . . Stan also received a very nice letter from **Ray Wong** of Ray Wong and Associates, Consultants, Civil and Structure Engineers, Kuala Lumpur, Malaysia. Ray plans to attend our reunion this June.

David W. Ulrich has been elected a vice-president of MacMillan Ring-Free Oil Co., Inc., N.Y. . . . **Ralph J. Preiss**, formerly on the staff of the diagnostic manager for the IBM 3081 processor, has been named associate editor of the *IBM Journal of Research and Development* this past summer. Ralph's wife, Marcia, continues her duties as a member of the dance panel of the National Endowment on the Arts. In August, their oldest daughter, Robin, soloist with the Pennsylvania Ballet, married Kai Wulff, actor on stage, screen, and television. . . . A note from **Nicholas J. Haritatos** says that he is heavily involved in metallurgical and bioengineering projects at Chevron Research. He notes that chemical engineers are a very versatile breed. His projects include phosphates, uranium, platinum, fructose and ethanol, in addition to the usual petroleum and petrochemical design projects.

Timothy M. Brown, Jr. writes that he is still with NASA at Johnson Space Center in the Shuttle Avionics Integration Laboratory. His wife, Bunny (Wellesley, '56), runs a girls' summer camp in North Carolina. . . . **Clifford M. Sayre, Jr.** is presently managing the International Division of duPont's Transportation and Distribution Department. . . . **John T. Fitch** has taken early retirement from M.I.T.'s Center for Advanced Engineering Study in May 1981 to become the executive director of the Association for Media-based Continuing Education for Engineers (AMCEE). . . . **Arthur Auer**, a surgeon practicing vascular and general surgery in Creve Coeur, Mo., writes a long note of his activities. In September 1981, he spent nine days in London while presenting three poster exhibits at the Vasuclar Surgery Symposium. Two presentations were on distal bypass vein grafting and limb salvage and one on the use of the Wang computer in a medical office and non-invasive vascular laboratory environment. Art went to Israel for ten days in October and presented a movie on the technique of distal bypass grafting and his results at the Rombom Medical Center in Haifa. He really enjoyed the trip, which was his first to the area, and he gathered a great deal of insight about the country. Art also spent a week in northern Ontario fishing a year ago June. He enjoyed spending an evening with **Irwin Grossman** in Dallas while at the vascular meetings last June. Irwin is the president of Investment Properties, Inc. in Dallas.

Amos Horev, president of the Technion-Israel Institute of Technology, is a prime mover in the Israeli nuclear power program. He is heading a panel of government appointed scientists, utility executives, and industrialists looking for a site for a nuclear plant which he estimates will eventually cost the Jewish state $1.5 billion. Nuclear energy has become most important to Israel since the return of the Sinai oil wells to Egypt. Horev does not anticipate any nuclear protest in Israel similar to that which has been seen in the U.S. He believes that Israelis understand that things like energy and water are vital to their existence. The design of the proposed nuclear plant and its manufacturing source is still in process. The designers will have to take into consideration that the plant will be located in the Mideast and will be subject to terrorist attack. Horev is the natural choice to head the committee looking into the creation of Israel's first nuclear power plant. He is now a major general in the reserves and has previously served as a chief scientist of the Ministry of Defense.

A reminder: our 30th Reunion will be in Boston Thursday, June 10, through Sunday, June 13. Starting with the traditional M.I.T. Night at the Pops, we will kick off a memorable series of days. Come and meet old friends and enjoy Technology Day, a dinner and dance at the Meridian Hotel, and a clambake at Wentworth-by-the-Sea in Portsmouth, N.H. You will also have a chance to tour Strawberry Banke and see the reconstruction of historic Portsmouth with your classmates. It's never too late to join us. Come with your spouse and make it a long weekend. We look forward to seeing you.—**Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, MA 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, CA 09301



How did Paul MacCready do it? To hear the answer, more than 140 alumni came to hear Morton Grosser, '53 (right), describe the flights of Gossamer Condor *and* Gossamer Albatross *at a meeting of the M.I.T. Club of Northern California late last year. Congratulating the speaker, above, are Mr. and Mrs. Gaynor Langsdorf. (Photo: Philip L. Molten, '55)*

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It is with deep sadness that I report the death of yet another classmate—Dr. **Roy Kaplow**. Roy died in January of an apparent heart attack. Our sincere condolences go to his wife Frances and his daughters Shana and Jordana. A member of the M.I.T. staff since earning his Ph.D. in 1958, Roy held a joint appointment as a professor in the Department of Materials Science and Engineering and in the Division for Study and Research in Education. His professional interests ranged from materials science, to solar energy utilization, to the use of computers for education. He was the author of more than 50 scientific papers and a text on x-ray diffraction, and he held 15 patents. At the same time, he maintained a deep concern for his students and for the educational process as well—attributes easily lost in the intense academic competition for grants and recognition. Roy served the Institute well and will be deeply missed by those of us who were fortunate enough to have known him. We are proud to have been his classmates.

On a positive note, **Jim Brown** has just been elected president and chief executive officer of the Austin Powder Company. Congratulations, Jim, and best wishes to you in your new position.—Co-secretaries: **William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

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After the cold winter we have experienced, you will appreciate the following note from **Laurence I. Moss**, Course X: "I am now designing energy efficient buildings for individual and corporate clients. Our home, high in the mountains of Colorado, uses no back-up heating to stay warm, though the climate here is about 60 percent colder (in degree-days) than Boston. We need no furnace, baseboard heaters, wood stove, or fireplace." Laurence has been in energy/environmental design and policy analysis since 1975. Laurence, his wife Anne, and their two children, Joshua (8), and Elisabeth (3), live in Estes Park, Colo.

Bob MacDonald, Course XVI, moved to Reno in January 1981 to join Lear Fan Corp. as aerodynamics supervisor working toward certification of the graphite-epoxy LF2100 turbo-prop. . . . **E. Carl Hanks, Jr.**, also Course XVI, married Lucille Templeton on January 20, 1981. Lucille is at IBM in personnel. Carl is a consulting engineer at Lockheed MSC. With the union of the two families, Carl and Lucille now have nine children, none at home, who Carl says are "...grown up and neat people on their own. Life is joyous." Having six children myself, I can appreciate the joy of knowing one's children have grown up to be neat people. . . . **Hans Hoefleing**, Course XIII, has been promoted to vice-president of marketing for the pump group of Ingersoll-Rand. In this position he will be headquartered in Houston. His concerns will be evaluating customer needs and the best products and prices to meet those needs—product development, pricing, marketing, and sales.

Clarence R. Westaway, '33, sent us an announcement of the candidacy of **Bruce D. Wedlock**, Course VI, for Region I director of the IEEE. Bruce has served as director of M.I.T.'s evening division since 1972 as well as a consultant in the areas of circuit design, solid state device design, and efficient power management.

Paul Polishuk, Course VIII, is president and publisher of Information Gatekeepers, Inc., an organization directed toward providing technical and marketing information to the telecommunications and computer industries. In December 1981 he headed an international mission to Japan to study Japanese development of fiber optics and its application. The mission was sponsored by Technology Transfer Institute. . . . **Robert Hochman**, Course VI, is now president of Forest Construction, Inc. . . . After 16 years with TELCOM, Inc. in Vienna, Va., **Ralph H. Gaze**, also Course VI, is moving to England to establish a consulting practice n communications system and instrumentation. . . . **Wendyl A. Reis**, Course XV, has been appointed vice-president of strategic planning for Drilco, division of Smith International. Before joining Drilco, Wendyl served as vice-president in the corporate finance department of First City Bank of Houston. He has also served as director/corporate planning for ACF Industries and as director/operations for ACF's W-K-M valve division.

Rather belately, news has reached us of the death of **Allen Kezer**, Course XVI, on August 24, 1979. He was president of Allen Technology in Wellesley. We have no other information about Allen at this time; maybe one of our classmates could provide us with other news about him.

Our call for news brought a great letter from **Roberto Perez-Amador**, Course II. He was hoping to attend our 25th Reunion, but business prevented it. At present he is with Exxon as project manager involved in the Colony Shale Oil Project at Colorado, but is based in California where part of the engineering is being performed. Roberto was from Cuba, as you may remember, and left after Castro took over. He lived in Spain for ten years after leaving Cuba, spent short periods of time in France and Puerto Rico, and in 1977 returned to the U.S. after rejoining Exxon. He is married and has 19-year-old fraternal twins, a boy who is attending the University of California at Irvine pursuing a mechanical engineering degree and a girl attending Saddleback Community College working toward a Spanish major.

Ron Goldner, Course VI, is professor of electrical engineering at Tufts University and a consultant for the electronic materials group at Lincoln Labs, where **Margie Cohen Gilson** works. Ron, his wife Judith, and their three children live in Lexington, Mass. Eric (20) is a junior at Tufts; Rachel (13) is in junior high and plays the violin; and Mark (11) is a trumpet and piano player and has a third-degree brown belt in karate!

The total for the Class of 1956 Career Development Professorship has reached $330,000. Since this is an ongoing fund effort, please continue to designate your donations to this fund as well as pay your five-year pledges. You may get only one reminder.

Keep your news coming—it certainly is interesting to hear what people are doing. Your western correspondent, leading a sheltered life, is amazed at the variety of interests and successes our class exhibits.—Class Co-secretaries: **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818; **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345

57 25th Reunion

I understand the Alumni Fund drive is doing well, and some very nice contributions have come in—we are in full swing and will want to finish up in fine style so keep the pledges coming. Keep your minds on reunion weekend and plan to be there! Class of '57 was represented in the Alumni Fund's fall telethon by **Bill Doughty** and **Art Aznavorian**. Remember that the spring telethon is coming May 10-13.

Mead Corp. of Dayton, Ohio has announced that **Steven C. Mason** will become president and chief operating officer effective in April. . . . **Michael Allik** was named senior vice-president, finance and administration, of Dart and Kraft, Inc., of Glenview, Ill. . . . **Bernard Silver** tells of his harrowing experience: "While technical climbing in the Washington Cascades, had vertical fall of 120 feet when three chocks failed to hold. The persisting fine conditioning from M.I.T. crewing, a climbing helmet, and a stout 145-pound ropemate, Charles Thompson, pulled me through. Just thankful to be alive." We share your thanks Bernie.

Lavette C. Teague was appointed professor of information systems, California State Polytechnic University at Pomona. . . . **John P. Penhune** is now the manager of the special systems division of Science Applications in LaJolla, Calif. . . . A January press release announced that **G. Stuart Patterson** was named a senior vice-president of Cray Research, Inc., Boulder division. Another press release from fall 1981 announced the appointment of **Harold W. Miller** of Butler, N.J. to group general manager of the Telecommunications Systems Group of ITT Corp. He was formerly president and general manager of ITT Defense Communications Division. A newsclip from the same time frame advised that **Charles A. Mortensen** was promoted to general manager at Split Ballbearing Division of MBP Corp. He resides in New London with his wife, Sandy, and their two sons.—**Fred Morefield**, Secretary, Shared Medical Systems, 650 Park Ave., King of Prussia, PA 19406



H. Miller, '57



G. S. Patterson, '57

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Mort O'Connor, Course VI, has just been promoted to GS17 in the Department of Defense and is now in charge of a major research and engineering organization. Mort lives in Silver Springs, Md., in case any of you are passing through. . . . **George Connor**, Course X, has just moved to the Washington, D.C. area—he was promoted to colonel in April 1981—and has been selected to be the first "Special Assistant for Chemical Warfare" in the Office of the Assistant Secretary of Defense for Atomic Energy at the Pentagon. He was married last July and is now the father of two girls, Pam (17), and Paula (11). He says, "All in all, an eventful year with many blessings." . . . And still another letter from a classmate who is associated with national defense. In this case, however, **Jerry Roylance**, Course XV, writes that he retired from the Air Force in March, completed RPI's M.B.A. program in December, and is presently looking for new opportunities in the Northeast.

In my last column I noted that **Robert Brooker**, Course XV, was named president of the Information Services group of NL Industries. Since that time, he has been named a corporate vice-president. . . . **John Brackett**, Course X, tells me that he has spent much of the last two years in San Diego as president of Softech Microsystems, a subsidiary of Softech, which John founded in 1969. He took his company public in 1981. Microsystems is a supplier of software products for such popular computers as Apple, TI, and IBM Personal. . . . A one sentence note from **George Yerid**, Course V: "Currently an orthopedic surgeon in the Chelmsford/Lowell area." . . . **Dick Sampson**, Course I, writes that his company, American Alarm and Communications, is now stopping approximately one burglary a day. He, **Chuck Staples**, and Bruce Wedlock, '57, started AAC in 1970.

Phil Beach, Course VI, has been spending a great deal of time in Buenos Aires. He is employed by Makro, part of the Dutch SHV Group, which specializes in wholesale cash and carry. If all goes as planned, the Beach family will be moving to Argentina shortly. . . . **Stephen Spooner**, Course III, has just joined the solid state division at Oak Ridge National Laboratory in Knoxville. His next sentence tells me that he is in the right place. "I understand there are some rowing activities in Knoxville. Perhaps after the loss of some unspecified number of pounds, they might let me into a shell." (Think about it.) . . . **John Stackpole**, Course XIX, has been elected a fellow of the American Meteorological Society.

Of course, no column is complete without a plug for the Alumni Fund. First, I hope everyone took advantage of the recent change in tax laws and squeezed an extra contribution into 1981. Second, thanks to **James Wixson**, Course II, who represented our class in the fall telethon. Third, the

spring telethon is coming up soon—May 10-13.

June and I saw Diana and **Phil Richardson** twice in New York City over the holiday season. It was an excellent opportunity to compare notes and swap stories on our two favorite subjects—classmates and the trials and tribulations of parents who have a child in the midst of applying to college. . . . Keep the cards and letters coming.—**Larry Laben**, Secretary, 310 Rockrimmon Rd. Stamford, CT 06903

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Some news from out west to report this month. **Richard Ottie** works for Raytheon in Menlo Park, where he has lived since 1968. He is the general manager of the Metals Division. . . . **Pete Gaposchkin** writes that he has been teaching at various colleges in the San Francisco Bay area since he left the Ames Research Center back in 1980. At Merritt College he taught physics until September 1981.Since then Pete has been teaching computer science at Cogswell College and San Francisco City College. . . . Way down south in Texas lives old **Rex Thompson**, where he has just started a company called Thompson Energy Consultants.It provides technical and economic feasibility studies as well as project development assistance to various petroleum and petrochemical industries. TEC is set up in Richardson, Tex. Rex reports that he bumped into **Bob Weimer**, **Jim Manganard**, **Martin Falxa, and Don Easson**, all from Course X, at the AIChE meeting in New Orleans last fall. . . . Back east: **Marshall Greenspan** writes: "I am still with Norden Systems in Norwalk, Conn. Recently, I was promoted to engineering manager, radar and electro-optic systems; however, the majority of my time is being spent working with the U.S. Air Force and Grummand Aerospace Corp. on an advanced airborne radar system development program." . . . **Richard Stifler** writes that he lives in Wellesley, Mass., with wife Linda and two kids, Timothy (8) and Emily (7). Richard makes his living as a psychiatrist in private practice. . . . Further east is the source of a letter from **Pete Bankson**, who has spent the last 18 months in Stuttgart, West Germany, working as a one-man program analysis and review shop for the "highest level" U.S. military headquarters in Europe. It's a blend of economic analysis, applied political science, psychology, and bureaucratic politics. Next summer Pete will retire from the Army after 21 years and start on a new career. Meanwhile, Pete and his wife Marjory will have time to "clown, ski and sightsee."

After going for a Ph.D. in math at the University of Kansas and a J.D. from Notre Dame in 1976, **Mike O'Neill** is now a practicing lawyer in Dallas, Tex. Mike had taught math at the Princeton Institute of Advanced Study, Northwestern, and Notre Dame before coming to his true calling: law. He and wife Jeanne have a son, Sean (7) and daughter, Shannon (2). . . . **Paul Fricke** has a somewhat older daughter, Laura, who is a National Merit Scholar at M.I.T. . . . **Harold Meyer** lives in South Windsor, Conn., and works for Hamilton Standard in Windsor Locks. . . . **Arthur Treiber** writes that he is now executive vice-president of PE Systems in Alexandria, Va. . . . **John Benjamin** is also an executive; he is general manager of INCO, mechanically alloyed products, working out of New York City. He runs the worldwide program to commercialize oxide-dispersion-strengthened material for gas turbines. He also works with NASA on space materials processing with emphasis on lunar and asteroid mining (wow!). . . . **Carl Karrfalt** recently married Ellen Simonsen. In the bargain he got a new son, Ronald, to go along with his own four children. They all live in Pelham N.H. . . . **Denis Healy** writes from Durham, N.H.: "It's damn cold up here." . . . **John Savage** was on sabatical leave from Brown University in Paris, but I suspect that by now he has returned to his usual duties. He was working at something called INRIA, a research lab near Versailles. . . . **Lawrence Rojahn** couldn't come to the class reunion because it conflicted with the Virginia Republican State Convention, where he was a delegate. . . . The pile of notes concludes with one from **Lloyd Lee** who says, "Since graduation I have moved through various positions at AC spark plug division of GMC. I am currently chief production engineer in the instruments and controls division." He lives in Grand Blanc, Mich.

I'll finish up this month's column with extracts from last year's questionnaire. The section on politics was pretty fascinating. Less than half of the class classified themselves as right of center back in 1971, but now class members have shifted rightward and about 80 percent describe themselves as conservative or middle of the road. An example of this trend was the 66 percent who thought that Kemp-Roth was the correct policy (the proposal would reduce taxes by 30 percent in the next three years). The majority supported increased defense spending, while only 16 percent felt spending on social programs sould increase. Ninty-one percent feel the U.S. should be militarily equal or superior to the U.S.S.R. Only 9 percent favored disarmament. Most people thought the U.S. was correct in withdrawing from Viet Nam. On specific issues there were two very interesting responses. Forty percent of the respondents said they didn't care about gay rights one way or another. I thought this was a hot issue. The other interesting response was on gun control. Seventy percent of the class favored gun control. Other strong reponses were to the teaching of evolution in school (54 percent against), socialized medicine (67 percent against), school busing (70 percent against), prayer in public school (56 percent against), legalized prostitution (54 percent for!), legalized abortion (84 percent for), and an increased space program (70 percent for). The majority of the class feels that the racial situation is getting better. Finally, people ascribed the current U.S. economic difficulties to government interference, poor business management, and OPEC—in that order. There is more material worth reporting from the questionnaire, so next month I will finish up with this report.—**Andrew Braun**, 464 Heath St., Chestnut Hill, MA 02167

62 20th Reunion

Erich P. Ippen, professor of electrical engineering at M.I.T., has been elected a fellow of the American Optical Society. . . . **John A. Rollwagen**, president and chief executive officer of Cray Research, Inc., designer of computers, has now assumed the chairman's title. . . . **Barry J. Fidelman** is now vice-president of marketing for Apollo Computer Corp., a new company. . . . **Keith M. Ferguson**, project manager for Hewlett-Packard Co., Santa Clara division, writes that he has been square dancing several times a week for the last six years and recently graduated from square dance callers' school. . . . **Gerald L. Parker** has started a company called Accusplit by purchasing a product line of electronic stopwatches. He lives in Saratoga, Calif., with his wife and five children.He recently saw **Paul Olmstead** at a Stanford seminar. . . . **Thomas F. Morgenstern** practices orthodontics in New Jersey and is president of the Mercer Dental Society. His wife Judy is area coordinator for Jackie Sorenson's Aerobic Dancing, Inc. . . . **Dan Thornhill** writes that he is still consulting with Sof Tech in Waltham, Mass., and is doing a lot of international traveling—would you believe 202 days out of the country last year? He visited with **John Stanley**, who is with Christian radio in Quito. Dan asks if anyone needs a tour guide for Rome, Florence, or Val d'Aosta. . . . **Peter Maas** is senior lecturer in applied physics at Strathclyde, Scotland, doing research in experimental population dynamics of algae and software for laboratory microcomputers. He also spends time doing financial planning for his department as government funding changes occur. . . . **Jeremy R. Goldberg** now visits Boston to see his sister-in-law and her family. His children Eliot, 12, and Devra, 10, were duly impressed by their visit to M.I.T. . . . **H. David Stein** has been promoted to associate professor of surgery at the Albert Einstein College of Medicine.

Our class was represented in the Alumni Funds's fall telethon by **Paul V. Teplitz** and **Erik V. Pedersen**. A spring telethon is scheduled for May 10-13.—**John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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You may not believe it folks, but our 20th Reunion is rapidly approaching. That's right, 20 years. Planning has already begun for the event, so mark your calendars. The reunion will take place on the weekend of June 10-12, 1983.(That's Friday night, Saturday and Sunday.) Current thinking is for an off-campus gathering, perhaps in the Cape Cod area. Anyone with thoughts on the subject, or who wants to work on the reunion, should contact our class president, **Ira Blumenthal** at American BHF Corp., 21 Cummings Park, Woburn, MA 01801, telephone (617) 938-1208. New England is lovely at that time of year, so make the reunion a part of your vacation plans. Bring your family and a classmate who hasn't attended a previous gathering. We usually get about 50 members of the class of '63 at these events. Let's have 100 at our twentieth.

Well, so much for the commercials, now on to the news.While talking to Ira, I learned that he is selling energy management systems at American BHF. I also spoke with **Larry Krakauer** while garnering reunion news. Larry is vice-president of engineering at Kronos Corp., a Boston area firm that makes microprocessor-based payroll time clocks. . . . I must also salute several class heroes this month—classmates who still remember how to write letters.**Steve Ditmeyer** reports that he and his wife Marty became the parents of a baby girl, Anne Stark, in March of '81.Steve says that if having a baby wasn't enough of a change of lifestyle, in September the Ditmeyers moved from Washington, D.C., to Minnesota. Steve is now director of research and development for the Burlington Northern Railroad. The family lives in a charming old Victorian house and is thouroughly enjoying life in the new community. . . . **Harold Solomon** wrote all the way from Japan. He spent last summer visiting New Guinea, where he says he learned that headhunters speak English better than the Japanese do. Well, maybe that's the way to get ahead. (Small joke there.)

I also have a whole passel of envelope flap notes from you: **Barton Cramer** says that he is a fugitive from Course VI.He just completed 15 years with Standard Oil of California and is working in computer processing as a senior staff geophysicist (!) at Chevron Geo-Sciences in Houston. Bart and his wife Betsy have lived in Houston for 11 years and would like to hear from other "settled" alumni. . . . **Vic Scheinman** is currently vice-

president for advanced systems with Automatix, Inc., a company making robotic automation systems. The company was venture-capital funded, in part by M.I.T. Previously, Vic was with Unimation, Inc., where he designed the PUMA robot, and before that he was president of VICARM, Inc., also a maker of robots. VICARM was sold to Unimation in 1977. Vic and his wife Bonnie have a daughter, Tenaya, aged 3. . . . **Frank Verlot** informs us that he was promoted to manager, strategic and business planning, at United Technologies Chemical Systems Division in Sunnyvale, Calif. Congrats. . . . **Rich Bernhard** writes that in May '81 he married Susan J. Dauer, a marketing assistant at Rexnord. They honeymooned in the Northeast and spent a day touring the Institute and Boston. (That's a new idea—M.I.T. as a honeymoon destination!) Richard is a self-employed computer consultant on assignment to Eaton Corp. . . . **Dean Boyd** is president of Decision Focus, Inc., a smallish (about 30 employees) consulting firm he cofounded about five years ago. They do decision-focused modeling and quantitative analysis in a variety of areas, but particularly in resource industries such as energy, forest products, etc. Dean divides his time between his office in Palo Alto, Calif., and a 30-acre homestead in the hills of Oregon, where he raises everything from a delightful eight-year-old to purebred milk goats.

Henry Nau has been working since January 1981 as a senior staff member on the National Security Council in the White House. His responsibilities include coordination of preparations for economic summits. He accompanied President Reagan to Ottawa and Cancun, Mexico, last year. Henry says the work is exciting, but difficult, and he believes that some good is coming from it. . . . **Frank Levy** and his wife, Kathy Swartz, report the birth of their second child, Marin Katherine, on June 11, 1981. Happy Birthday. . . . **John Tytus** is working as a software engineer at Storage Technology, Inc., and trying to learn to play jazz piano. . . . **Marco Falcon Ascanio** spent a sabbatical year as a special student in chemical engineering during 1975-76. He stayed on to get his Ph.D. in the Department of Mechanics and Hydraulics at the Iowa Institute of Hydraulic Research at the University of Iowa. Then he returned to his faculty post at the Instituto de Macanica de Fluidas, Universidad Central de Venezuela. . . . **Steve Zilles** is still enjoying working for IBM in San Jose, Calif. He is involved with simplifying software development for office workstations. Steve recently served as the Pacific regional representative on the Association for Computing Machinery Council. His wife Connie is teaching at West Valley College, and they are both interested in scuba diving. Sons Karl, 11, and Craig, 9, are avid soccer and basketball players. Steve coached Karl's soccer team to a winning season in 1981. . . . **Ron Walter** left city government two years ago for work in the private sector. He is vice-president for planning and business administration of Citicorp's equipment finance/leasing business. The Walters still live on Roosevelt Island in New York City, and Ron commutes to the suburbs. His office is located in Harrison, N.Y., in Westchester County.

Would you believe that I still have more notes? But I will save them for next time in case you are less inspired during the coming months and don't provide any new material. One final note, folks, from your class secretary. I have been doing this column for nine years now, and I will for another year. I am looking for a volunteer to take over this space for the next five to ten years. I'll pick it up again, if you wish, after our 30th Reunion. Anyone interested certainly knows my address.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

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Jerry L. Dassel is presently head of the Casting Technology Section at Kaiser Aluminum. Jerry is living in Pleasanton, Calif. with his wife Jerilynn and their three children—Amanda (8), Elizabeth (5), and Mark (3). . . . Late last summer, **David J. Dunford** left for Cairo, Egypt, to take an assignment as economic counselor for the U.S. Embassy there. On October 6, when Egyptian President Anwar Sadat was assassinated, David was on the reviewing stand. For several days his family was confined to the embassy compound, prompting them to seek information from David's mother, Mrs. Katherine Dunford, as to what was happening. David, his wife Sandi, and their children Gregory and Kristina have since returned to their home just outside of Cairo. Prior to this assignment with the state department, David worked for Bill Brock at the U.S. Trade Representative's Office. . . . In May 1981, **Ron Gilman** was honored as the recipient of the Sam Myar, Jr. Memorial Award, presented annually to a Memphis lawyer under age 40 for "outstanding contributions to the legal profession and the community." Ron has also become a member of the International Brotherhood of Magicians and enjoys doing amateur magic for children. . . . Now from the other side of the country—**John Graham** advises us that he is staff psychiatrist at North County Mental Health Center in Daly City, Calif., and has his own private practice. He and his wife Elly and their two sons, Michael (10) and Peter (4), live in Mill Valley, Calif. . . . **Robert Gray** is editor of *IEEE Transactions on Information Theory.* He received a fellowship from the Japan Society for Promotion of Science for lectures in Japan in November-December 1981. He also received a Guggenheim Fellowship for January 1982 until September 1982 which will be spent at Stanford University and the University of Paris. . . . Last April (1981), **Larry Greenley** joined Bethesda Research Laboratories in Gaithersburg, Md., as chromatography product manager. He and Rosalie and their four chiildren reside at 2222 Carmichael Dr., Vienna, VA 22180, for those who may wish to write.

Bruce Hopkins says he has spent the last 15-odd years in the manufacutre of X-ray film, medical devices, iron castings, paper shipping sacks, and now grocery bags. (He did not say what he did during the "even" years.) Bruce and Marion and the boys moved from Cincinnati, Ohio, to Richmond, Vir., last July, where Bruce has "taken up the reins of Champion International's Grocery Bag Division." They would welcome a call from any classmates in the Tidewater area. . . . Last September, **Leon Kaatz** spent two weeks mountain climbing in Peru and hiking the Inca trail from Cusco to Machu Picchu. . . all in all a "fantastic trip." **Ashak S. Kalelkar** was recently elected vice-president of Aruthur D. Little, Inc. in Cambridge, Mass. He manages the safety and engineering technology section within the company. . . . **Bruce Knobe** is now manager of the Programming Languages and Compilers Department at Intermetrics, Inc., Cambridge, Mass. . . . **Mike Monsler** continues as manager of energy applications of laser fusion at Lawrence Livermore Lab at the University of California. Luckily for Mike, this year has included business trips to Vienna, Paris, and Tokyo. Back at home he and his family love the San Francisco Bay area and are looking forward to the best ski year ever in the Sierras. . . . The newest arrival at the **Robert Popadic** household is William Peter Popadic, born on January 24, 1981. Happy 1st Birthday!! . . . **Lawrence Rabiner** is supervisor of the Acoustics Research Department at Bell Laboratories. The Rabiner's have three children Sheri (10), Wendi (8), and Toni (2). . . . **Ron Randall** has formed Electronic Funds Management Corp. to develop a competitive service to Merrill Lynch's cash management account. Ron says that 15 banks and Investors Diversified Services have already worked with EFM in early systems design, and a major financing is in the works. He is getting much-needed strong moral support from his wife Sally and daughter Stephanie during the early phases of "this risky venture." Good luck, Ron! . . . **Stephen E. Straus** is head of the medical virology section, Laboratory of Clinical Investigation, National Institute of Allergy and Infectious Diseases, NIH, Bethesda, MD 20205. His current research is in molecular biology and treatment of human herpes virus infections. . . . **Ralph Zimmerman** is now senior chemist at Amchem Products in Ambler, Pa., and his wife Nancy is a program officer at the William Penn Foundation in Philadelphia. The Zimmermans are living near Princeton, N.J. Ralph is still involved in fencing, having spent his vacation last year officiating at the Junior World Championships.

Joseph E. Boling has been promoted to lieutenant colonel and is currently stationed at Fort Benjamin, Harrison, Ind. His new assignment is chief of the MIS Division in the Doctrine and Combat Developments Directorate, where he is responsible for functional design of personnel support automated systems (hardware and software) for the Army (including the doctrine for their use). Joe's wife, Louise, is a public health nurse for the county, and she is resuming academic pursuits to complete her master's degree in nursing. . . . Now living in Connecticut with his wife and three children is **Seth Bredbury**. He is an independent consulting engineer, doing most of his work with the firearms industry. An interesting aspect of this work involves Seth's serving as an expert witness in a number of product liability suits.—**Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20854

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Doug Spreng and Barbara Harriman of Portland, Ore., were married last July. Doug is still general manager of Hewlett-Packard's disc memory division and reports that he kept busy by introducing four new disc memory products in October. Doug and Barbara are enjoying life in Boise, Idaho. . . . **Jim Pearson** and Gail Schnakenberg were married in March 1981. Jim reports that Gail and **Ed Bucher** were present for the wedding. Jim is still in industrial marketing for the Brunswick Corporation's vapor division, and Gail is a C.P.A. for Harris Bank in Chicago.Ed Bucher also sent a note reporting Jim's wedding (but nothing about himself). It's nice to know about the weddings. I wonder how many bachelors are left out there.I had always assumed that I was one of the last when Anne and I got married two years ago.

Hank Lichstein reports that he is still with CitiBank in New York as group treasurer in consumer banking. He says he was in Cambridge this fall recruiting and that life seems slow in the M.I.T. academic community by contrast with the New York business world. Hank also reports that winter is "always a downer for a California boy" (Texans too, Hank). . . . Naida and **Dave Cohn** are on sabbatical from Notre Dame and spending the year in Israel at the Technion. Dave invited anyone passing through to visit—though I suspect the year will be over by the time this note makes the magazine. . . . **Steve Roth** is teaching physics at John Jay College in Manhattan, where he lives with his wife Margaret and their two daughters. . . . **Kim Kimerling** has been appointed head of the Materials

Physics Research Department at Bell Laboratories in Murray Hill. . . . **Jesse Lipcon** is a fellow employee at Digital Equipment and was recently named the company's eighth senior consulting engineer. That is the company's highest technical position and reserved for people who are outstanding contributors to products, technologies, and innovative concepts. Jesse has been at Digital for nine and a half years and is now technical director for the PDP-11/16-bit development group in Central Engineering. . . . **Bill Pike** is still at Fidelity Management (after nine years) and is now portfolio manager of the Fidelity High Income Fund, which specializes in low-rated bonds. Bill is writing a book about the stock market that he hopes to publish this year. . . . **Dave Rubin** wrote that he is working for COMSIS, a transporation planning firm in Maryland. He says they are involved in all sorts of things like ridesharing, light rail transit, and accident statistics. Dave and Sharon live in Columbia (nice town!) and just bought a house in the woods, a five-minute walk to the Columbia Mall.

Frank Gerstle reports that he is serving on the National Materials Advisory Board Committee on Lightweight Combat Vehicles as well as doing research on creep-rupture of Kevlar composites. Frank says he is planning to make the world unsafe for upper management and is active in the local mountain rescue organization. . . . **Bruce Morrison** is running for the Democratic nomination for the Third Congressional District seat from New Haven, Conn. Bruce has a law degree from Yale and has spent the last five years as executive director of the New Haven Legal Assistance Association. . . .**Art Bushkin** says that his new consulting firm, Telemation Associates, is doing well and that he is enjoying being an entrepreneur, though it is more difficult than he had imagined. . . . **John Holdren** was one of 19 winners last November of the MacArthur Foundation awards. John will receive about $38,400 a year tax-free for the next five years. John is a professor of interdisciplinary energy studies at the University of California, Berkeley, and has been on sabbatical this year.

This column is written in what I hope will be February's last cold snap. We spent last week in Florida during the February school vacation, then came back to work and the cold. Florida was lovely, but it was 10 degrees Farenheit when we got up this morning. I type May-June at the top of each page of this column and think of spring. Enjoy.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

67 15th Reunion

We hope to see a record number of you at our reunion June 11-13. Do attend.

Alan Hayes was recently appointed to the research faculty at the University of Utah where he does research on VLSI devices. He is an official in the U.S. Ski Association competition program in Utah-Idaho-Wyoming and was licensed as a TD (technical delegate) by the Federation Internationale de Ski this year. . . . **Fred Hottes** writes that he had a chance to visit with **John Forster** while passing through Boston last summer. He hopes to be able to attend our class reunion. . . . **Jerry Tomanek** recently joined Econics Corp. as vice-president of marketing. Econics makes automatic combustion control systems to save energy on large boilers and process heaters. He and his wife both made vice-president the same week—Susan is a vice-president at Wells Fargo.

The big news for **Mike Zuteck** this year is a first place in the 1981 CORK regatta in the Olympic Tornado catamaran class. The regatta carried the North American and Pan American titles with it and was a ten-year anniversary of a victory in 1971. The finishes were 1-1-1-2-1-1-1 in a 45-boat fleet with entries from as far away as Argentina. Mike writes: "Long live the M.I.T. sailing program of which I was fortunate to be a part." . . . **Howard Gillis** is on active duty with the U.S. Air Force in Europe as chief of aeromedical service for the 81 TFW at RAF, Bentwaters, England. He spends considerable time traveling throughout Europe providing medical support. . . . **Greg Zacharias** is senior staff scientist at Bolt, Beranek, and Newman in Cambridge, Mass. Greg and his wife are expecting a new baby this year; son Owen is now pushing the ripe old age of 3. . . . **Alan Hausrath** lectured in Colombia, South America, for three weeks during the summer of 1981.

I'm saddened to report that **John Macrae** died last November after suffering a pulmonary embolism. John was a project manager of the Commonwealth of Massachusetts' transportation building project in Park Square and a consultant for several real estate projects in Massachusetts and Canada. He previously served as a consultant to the MTA. John spent much of the time in Boston and Goshen and was very active in government and community activities in Goshen. He was a member of the Handel and Haydn Society in Boston and Les Amis du Vin.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

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We just returned from a two-and-a-half week trip to Hawaii—a delightful way to end what seems to have been a cold and altogether unpleasant winter—and opened our mail to discover a flurry of birth announcements. Robert (Ph.D. '70) and **Margaret Keller** sent an announcement of the birth of their first child, Karen Marie, on January 9, and Linda and **Harvey Newman** sent an announcement of the birth of their third child, Matthew David, on January 27.Harvey and Linda previously wrote to say that, after eight years in Europe, they are returning to the U.S., where Harvey has accepted an associate professorship at Caltech.They bought a home in Altadena but still plan to spend the summer back at DESY in Hamburg.Other birth announcements have filtered in more slowly through *Technology Review*. Kathleen and **Robert Young** had twin daughters, Elizabeth and Victoria, born March 21, 1981. The Youngs continue to run their company, Photographic Specialties, from their home, but it gets hectic at times with two little girls around. . . . **Andrew Jennings** announced the birth of a daughter, Susan, on July 25, 1981. He also has two sons, Andy Jr. (6), and William (3). . . . Aslaug and **Jack Zeigler** had their first child, a boy, October 3, 1981. . . . Pam and **Scott Marks** had their first son, Steven, in June 1981 and are enjoying parenthood and living in the New York area, where Scott is now senior vice-president for consumer card marketing at American Express. He is responsible for marketing their green and gold cards in the U.S. "The Institute's curriculum obviously has broad application!" he writes. . . . Finally, Heidi and **Pete Amstutz** had their first child, daughter Emilie Allison, way back in January 1981 in Frankfort. Pete is still working for First Chicago as head of their Eastern European office there, and Heidi finds being a mother a full-time job. Emilie is Swiss and American like her parents and already shares their love of swimming.

Special kudos to **Laurence Smith** for writing us for the first time to let us know that he is married and has two children, ages 1 and 7. He completed his Ph.D. in physics in 1975 at the University of Illinois, working on nonequilibrium superconductivity. He did a postdoc at Harvard from 1975-79, and is currently at Sperry Research Center in Sudbury, Mass., working on the Josephson Devices project. He lives in Lexington. . . . **Bob Metcalfe** writes us that he is married to Robyn Shotwell and living in San Francisco. They have two companies, each about two years old. Bob is at 3Com, where six of the 31 of them graduated from M.I.T. They connect computers together, "especially with my baby, Ethernet." . . . **Dave Cahn** is now with Comsat General Integrated Systems in Palo Alto as project manager for data systems. The company is engaged in the development of integrated computer aids for design and manufacturing. Dave also participated recently in the International 505 Class World Championships, finishing about midway in the 86-boat sailing fleet in his first attempt at this title. . . . **Daniel Harris** moved to Franklin and Marshall College in 1980, where he is professor of chemistry, teaching general and analytical chemistry, and continuing to do research on iron proteins. His second book, *Quantitative Chemical Analysis* will be published next summer.

After two years with the navy at Guantanamo Bay, Cuba, **Robert Handel** has now opened a surgical practice in Brevard, N.C. . . . **Harry Goldmark** is busy in his practice of orthopedic surgery in Leominster, Mass. His hobby is flying, and he likes to spend his free time flying with wife Nancy and sons Jamey (3) and Brian (1). . . . **Bill Carlson** moved to Laguna Beach, Calif., in January 1981. He is keeping busy as vice-president at Western Digital in charge of Advanced Systems, and is enjoying life in California. . . . **Charles Meyer** is living in London where he works as director of European marketing for Weight Watchers International. . . . **Karen Brothers** has joined the staff of Warner-Eddison Associates in Cambridge as director of the computer department, and fills the rest of her time serving on the Wayland Finance Committee. . . . Another classmate in the computer business, **Peter Jax**, has spent the past few years building up his computer business, and recently opened a new "business computer store." This process has necessitated his learning the skills of marketing and selling, which weren't part of his course load at the Institute. Peter's leisure time is spent with Vicki, Robby (5) and CJ (2) at the beach or traveling in the Western states, and periodically getting together with other members of Phi Sigma Kappa on the West Coast.

In April 1981, **David Ellis** opened his own law practice in Clearwater, Fla., specializing in computer and communications law and other science and technology related law areas. He is also president of the local (Tampa Bay area) M.I.T. club, and an educational counselor, interviewing high school students applying to M.I.T., which he finds very rewarding. With his wife and two-year-old daughter, he spent part of last summer in the Canadian Rockies and Laurentian Mountains north of Montreal. . . . Also working in the field of computer law is **Richard Raysman**, who is writing a monthly column on the subject for the *New York Law Journal*. . . . **Leonard Goodman** has been living and working in the Cambridge area. He was recently in California for two months working for his company (Intermetrics) on the computer systems for the space shuttle. He visited with **Dave Pack**, his wife Diane, and their two children, as well as with John Lindley, '67, and his family. He will be heading back to California to work for one year at his firm's Huntington Beach office, doing development on the space shuttle computer support system.

After leaving the Air Force in 1975, **John**



McFarren received an M.B.A. from the University of Cincinnati and spent several years as quality control supervisor for an Owens-Corning Fiberglass plant in Jackson, Tenn. "In my latest fit of madness," he writes, he decided to apply to law school, and is now a first year student (Class of '84) "buried" at Cornell Law School. Several others report they are presently in school, I don't know whether as a result of "fits of madness" or not. . . . **Ellen Greenberg** is working on her dissertation for a Ph.D. in management at Columbia University, and **David Turkel** is in his third year at New Jersey Medical College. . . . **John Barravecchio** is finishing his residency in internal medicine and plans to go into practice in the Boston area.

Our Intrepid Explorer of the Month award has to go to **Bill Charles**, who, together with Dick Holthaus, '69, and Al Schultz, '69, was planning, when he wrote, a 10th anniversary repeat last October of an unforgettable hiking trip on Mt. Katahdin in Maine. He is also seeking the whereabouts of George Sweeney, '71, the fourth intrepid climber on that original trip. Can anyone help him?

On a sadder note, we have to report the death of **William Demarest**, September 29, 1981. He had been vice-president of operations for P.H. Doremus Chemical Co., North Arlington, N.J., and president of the William C. Demarest Environmental Equipment Co., Bloomfield, N.J. On behalf of the class, we extend our deepest sympathy to his wife, Karen, and family.

The years do have a habit of rolling by, and next year, believe it or not, marks the 15th anniversary of our graduation and an opportunity for another gala reunion. We are looking for some volunteers to form a committee to help organize the festivities. If you're interested, please get in touch with us.—**Gail** and **Michael Marcus**, Co-secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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Well, I wish I could say that I've been in an accident or some other great excuse for missing the last few issues, but it's mainly been work and travel. Our 12th Reunion was quite successful, with a few more classmates present than last year. Hosted by the **Najarians**, once again Sina provided more good food than we could possibly eat. As weather was sunny and warm, we spent most of the afternoon on the beach, where I got a bit too much sun and spent the evening covered with yogurt, an old Armenian sunburn remedy.Mary Joan and **Bruce Nappi** brought their daughters, Aurianne (7) and Alana (5). Bruce, who went to California to work in the aerospace industry and later moved to Connecticut, is now working with the Ikon Corp. in Cambridge.

Bruce Anderson, whose latest book is *Passive Solar Energy*, brought as his guest Deborah Napior, editor of *Solar Age* magazine which Bruce publishes. Based in Harrisville, N.H., the magazine's circulation is approaching one million and appears to be as successful as Bruce's publishing company. Layne and **Jeffrey Lepes** brought their children, David (7) and Debbie (9); Jeff is still vice-president at Marshall Paper Tube Co. in Randolph. **Tom Linkas**, still with Putnam Management Co., and Pat and **Don Uhl** still with Combustion Engineering in Windsor, Conn.—rounded out the attendees.Now for some news on growing families. **Michael E. Solin**, in family practice in Leesburg for the last five years, married and has two children.

Carolyn S. (Leach) Scott, mother of four, is living on a mini-ranch in northwest Nevada with her children and husband, a professor of chemistry at the University of Nevada, Reno. . . . Cathy and **Lee Dilley** announce the arrival of their latest, Paul Allen, born last fall. . . . Kathy and **Brazos Guido** are currently restoring an old 26-room house in the Monte Vista historical district with the assistance of Angela (6), Vanessa (5), and Anthony (2). . . . Back in Massachusetts after ten years, **Richard S. Gawlik** returned with his wife and four children. He is manager of planning and analysis at Exxon Solar Power Corp. in Woburn.

Two years ago **Stephen C. Poppe** married Barbara Liberman and is proud to announce the birth of Sabrina. Steve received his Ph.D. in operations research from Berkeley last year and is vice-president at Robert Cliff & Associates, a management consulting firm (banking) in the Bay area. . . . Gilda and **Charles Guttman** are enjoying their first child, Rebecca Leah, while Charles spends his days as a patent attorney at the law firm of Hubbell, Cohen, Stiefel, and Gross in New York City. . . . Jamie (3), Mariah (4), and Sally and **Jim Kornberg** are living in Boulder, Colo., where (after getting his M.I.T. S.B. and S.M., Harvard Sc.D., and his board certification in occupational medicine) Jim has his own medical consulting firm and clinic—Comprehensive Occupational Health for Business and Industry. . . . Carl and **Lenore (Hass) Jones** are still in California. Besides caring for Matthew (5) and Karen (2), Lenore works for Research Libraries Group at Stanford managing part of the on-line library system development for their member libraries.

Denis A. Bovin is now a managing director at the investment banking firm of Salomon Brothers. . . . **Max Tabak**, after years as a particle physics postdoc, is now with Lawrence Livermore National Laboratory working on inertial confinement fusion.

John R. Selin is heading up a monolithic microwave integrated circuit design group at Raytheon in Wayland, Mass. . . . Living in Huntington Beach, Calif. with his wife and two sons, **Jeff Geier** is working in the area of digital image processing at Northrup's electro-mechanical division. . . . After eight years at DEC, **David A. Crane** has left to become director of hardware engineering for Mass. Computer Corp. of Acton. . . . **Steven M. Maser** is now associate professor of public policy and public management at the George H. Atkinson Graduate School of Management at Willamette University, Salem Ore. . . . **Burt S. Barnow** is currently director of the Office of Research and Development in the Employment and Training Administration of the U.S. Department of Labor in Washington, D.C. . . . Up in Wausau, Wis., **Talal A. Kheir** has opened a mail-order software house for microcomputers and systems.

An all-star cast (left) for a "night with the president" at the M.I.T. Club of Northern California early this year (left to right): Angus N. MacDonald, '46, president of the Alumni Association; John M. Davis, '67, who received his 1981 Lobdell Award; President Paul E. Gray, '54, of M.I.T.; H. DuBose Montgomery, Jr. '71, and Denman K. McNear, '48, president-elect of the Alumni Association. (Photo: Philip L. Molten, '55)

This covers about half the backlog I made for myself. I'll catch up next issue, when I'll also give details on our 1982 class reunion.—**Robert K. Wiener**, Secretary, Box 27, M.I.T. Branch, Cambridge, MA 02139

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Gim P. Hom writes: "Have moved from Tenn. back to Mass. and am with DEC as a strategy and pricing manager.Have one daughter and am expecting a second child in January. Would like to get all fraternity brothers and family in the area for a picnic. I can be reached during working hours at (617) 493-1349 or at home (617) 897-5191." . . . **Randolph M. Gregg** is investing in rental houses and a rowing shell. He rows the shell on an artificial lake half-a-mile from his home. . . . **Nancy (Liebman) Rosenfield** and Don Rosenfield ('69) moved to Lexington last February. Nancy is a senior programmer/analyst at Mass. Software Corp. in Cambridge, and Don is a consultant at Arthur D. Little. They have two children: Jennifer, 7, and Todd, 3. . . . Our class was represented in the Alumni Fund's fall telethon by **Jim Shields** and **Stanley Tillotson**. . . . **H. Carey Probst** is the New York area manager in the planning services division of Management Decisions Systems, Inc. His responsibilities include consulting and delivering financial decision support systems applications for clients in the New York area. . . . **Len Tower** is working for Te Corp., and Carol is a math and science textbook editor for Houghton Mifflin; they live in Somerville, Mass., where they have bought a house. They had a three-and-a-half week trip to Europe and are offering shows of their 500 slides. . . . **John Kulp** is vice-president for research and development of Symbolics, Inc., at its research facilities in Cambridge. Symbolics produces computer systems that facilitate symbolic computation as well as numerical computation.

Springtime is coming to Texas, and we are going to Europe.—**Hal Moorman**, P.O. Box 1808, Brenham, TX 77833

72 10th Reunion

Egad, you mean you are one of the few people who has not yet let us know that you are coming to the reunion? (June 11-13, Friday evening: a get-together at the M.I.T. Historical Collections and the new rink; Saturday: Endicott House; Sunday: brunch at Hancock Tower Summit Room; and more, all for a mere $65.) Run, don't walk, to call **Bonny Kellermann**, 59 Eliot Crescent, Brookline, MA 02167, (617) 232-0988 (home) or 253-3354 (office); **Dan Bloom**, 646-7051; or me, 843-5864, for details. Also, in a spirit of utter nondiscrimination, we would like to invite any non '72ers who have friends enough in the class to be reading this column. Join the scads (over 100 in January and returns increasing daily) of people at this truly classy event.

Lewis Jester writes, "Currently an adviser in Standard Oil of California's foreign operations staff and recently visited Aramco in Dhahran, Saudi Arabia. Family now totals four as my wife Suzanne gave birth to Lindsay Alexandra November 20 to join Larissa Tiffany, now 3½. We're building a female dynasty." . . . **John Krzywicki** writes, "In May 1981 I was promoted to principal of Cambridge Research Institute, a management firm. Last fall Lelon (Wellesley '75) and I went to Ocktoberfest in Munich and then to Alsace, Champagne and Paris." . . . **William Rouse** is head of the Center for Man-Machine Systems Research at Georgia Tech. . . . **Terrill Chang** reports, "I am now in a new job as senior mechanical engineer with SCS Engineers.I'm still married (or isn't that an acheivement anymore?) and living a life of suburban bliss in the Rainy City." . . . **Norman Kohn** is with the neurology department at the University of Chicago. His wife Lisa is expecting a child in June. . . . **Joel Bergman** is with ADP's Brokerage Services Division as a time sharing tech rep.

Brad Billetdeaux writes, "In May 1979 I received an M.S. from Columbia in operations research. That was part of a long-term trend from chemical engineering toward the decision sciences. In July 1980 I left Caltex Petroleum (after eight years) to join Exxon, where I am in the Communications and Computer Sciences Department at the data center in Florham Park, N.J. Believe me, there is an advantage in working for a company whose name is a household word. There are many M.I.T. people here as Exxon Research and Engineering is also here. I am involved with systems development for mathematical programming models. That should qualify me for the 1 percent club—only 1 percent of employees have any kind of clue what their job really is." . . . **Bob Ebert** is finishing a Ph.D. in clinical psychology from the University of Wisconsin and is on the research faculty at B.U. . . . **Eugene Kroch** teaches economics at Columbia. . . . **S. Michael Strain** is a grad student in molecular biophysics and biochemistry at Yale. . . . **Shirley Wilson** is completing the residency requirements for an Ed.D. in secondary math education and is starting her dissertation proposal. . . . **James Roxlo** wrotes, "My wife, Rita Heckvotte, and I are busy climbing DuPont's corporate ladder. We are both assistant technical superintendents. For those who say it can't be done, we report happily to the same boss." . . . **Robert Reiter** notes, "After finally completing my Ph.D. in computer science in December 1979, 1980 was an exciting year: I took my first 'real' job in the Software Technology Department of IBM's Federal Systems Division, my wife Lowrie (Garland '72) and I had our first child, a boy, and we bought a house in Bethesda, Md. 1981 has been more relaxing, but we are expecting another baby in May. We continue to witness Jesus Christ as our Lord and Savior." . . . **Paul Karger** writes, "I'm still doing computer security research for DEC, but my office just moved from the historic old mill in Maynard to a brand new building in Hudson. Steve Lipner '65, and I have been teaching a seminar on 'Protecting Data and Information' at various sites around the country."As you can see, there was quite a bit of news this month.Even more is available at the reunion. I hope to see you there.—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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Greetings from hyah again. **Roy T. Lydon** has, along with wife Mary Paula, become the parent of Roy T. Lydon, III, on September 30, 1981. He joins sister Mary Elizabeth, age one. Along with building a new home in Clinton, Conn., he has been appointed vice-president of Computer-Aided (not "Rated," there, M.P.L.) Design for Sunsearch, Inc., of Guilford in solar R&D. Roy is also a visiting lecturer at Yale's Graduate School of Architecture. . . . **Debra Judelson**, M.D., has progressed all the way from M.I.T. to Beverly Hills, where she is a cardiologist. She sees classmate **Eric Willsky** at Cedars-Sinai Medical Center on rare occasions and is working very hard. . . . **Steve Waller** is a third-year med student at USUHS. Wife Jane Ward (Wellesley '72) is also a third-year med student there.Daughter Katie ('03) is "pure pleasure," more so perhaps than dog Hildey, age 15, orthopedically sound but weak in the eyes and ears. . . . And, **Joel Bergman** left Manufacturers Hanover after five-and-a-half years to work for the Brokerage Services Division of ADP. Joel is a client services representative in the financial time sharing service.

Ruth and I are the proud holders of a contract (upon which we hope closing is imminent) on 13.2 of Virginny's choicest acres with views and all kinds of other good stuff. Lord willin', we'll get our house sold and start building shortly. More to come.—**Robert M. O. Sutton, Sr.**, Secretary, 819 Buchingham Ct., Warrenton, VA 22186

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Congratulations to **Patricia Callahan**, who has been named a vice-president of Crocker Bank. She manages the corporate services product management department of Crocker's Operations Division. Crocker is based in Los Angeles and San Francisco. . . . After working for four years in transportation planning, **Laura Smith** returned to Sloan for the Accelerated Master's Program. Now she is in Seattle working for the Port Authority. In January she married Bill Brown (Sloan '81). "I'm enjoying life in the Northwest," she says. . . . **Lawrence Kahn** is working for EG&G in Gaithersburg, Md., as an ocean engineer. He headed a U.S. all-star tiddlywinks team on a very successful tour of England last summer. He is also interested in bridge, frisbee, and boomerangs. No doubt he picked up the latter interest during his Australian tour in 1980. He holds the title of secretary-general of the North American Tiddlywinks Association. . . . **Kalev Ruberg** says that "Before Reagan had a chance to get rid of architectural research at NBS" he left for a teaching position at the College of Architecture at Georgia Tech. "With Cris Benton (M. Arch. '78) we have a fine energy research unit. Cheers Conner 5!"

Carlos Alberto Riva and Diane La Rossa were married in Cambridge. Carlos is attending the Harvard Business School.Diane is a graduate of Simmons College. . . . **Donald E. Shobrys** completed a Ph.D. in operations research at Johns Hopkins. He is working for Exxon Production Research in Houston, planning offshore development of oil and gas fields. His wife, Carol Aronson (Northwestern '77) is a project engineer at Setpoint, Inc., a consulting firm in the area of process optimization and control. "We are enjoying Houston, and we are taking advantage of the climate bygrowing all kinds of things in our garden (some of which we can even identify)." In addition Donald was planning to run in the Houston Marathon. . . . After graduation from M.I.T., **Joel Voelz** returned to Milwaukee where he was the treasurer for a small chemical company. He got an M.B.A. from the University of Chicago in '78. He spent the next two-and-a-half years in a planning department at Texas Instruments in Dallas. He is currently a partner in a consulting firm, Dallas Consulting Associates, with three faculty members from S.M.U. The firm works in marketing, small business, executive education and finance. His wife Lois (Harvard '75) works at Texas Instruments in labor relations. . . . **Harlan R. Davis** is "still selling various low and high technology product lines with my sights on something in the CAD/CAM industry. For the last six months I have also been a part-time FAA Certified Flight Instructor. Either I am teaching well or my students are just smart, as my first three students have passed with flying colors."

John A. Pershing, Jr., is working for IBM research in Yorktown Heights, studying the problems of computer networking. . . . **Evan Schwartz**

is in residency in orthopedic surgery at Albert Einstein College of Medicine. . . . **Gary Bogossian** is a "struggling young architect, registered in Pennsylvania." . . . **Anita Horton**, our former class president, has moved to the West Coast and joined the International Department of Crocker Bank.—**Alex Castaldo**, Secretary, 929 Mass. Ave. (12D), Cambridge, MA 02139

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The mails have been particularly kind. Word from **Dan Dershowitz** and wife Debbi Gross, '77, indicates that he received his Ph.D. in chemical engineering from the 'Tute in January 1982. Dan and Debbi then took a one-month vacation in the Orient. The news was sent, incidentally, via a postcard from Kowloon, Hong Kong. . . . From **Garret Davies**: "Fled the cold air and warm friends of Chicago for a position in the corporate planning department of Shell Oil Co." . . . **Allen Kantrowitz** writes, "Starting a residency in neurosurgery at Mt. Sinai Hospital in New York city." . . . From **Carla Baker**, "In August I started a new job working for Symbolics, Inc. They manufacture LISP based personal computers. I am working on computer-aided design for VLSI chips." . . . **Said Sahin Tulga** has been "promoted to chief, research and development, Drilling Resources Development Corp. of Davisville, R.I., and Tulsa, Okla." . . . **Wayne Hamburger** has "spent two weeks in November traveling around the beautiful state of California.Visited with fellow classmates **Sharon Zito** (University of California at Davis Veterinary School), Al Czerwinski, '75 (Univeristy of California at San Francisco Medical School), and Steve McDonald, '74 (University of California at Berkeley, Ph.D. in physics). All enjoying the northern California lifestyle." . . . **Russell Chapman** has left his job as analytical designer at Beckman Instruments to enter gradaute school at Caltech in applied physics. "Plan to do a thesis on laser spectroscopy. Have enjoyed a lot of hikes in California's mountains." . . . **Ira Gerson** is "working for Motorola Corporate Research in Shaumberg, Ill.Married in 1978. President and founder of the Pamela Beth Gerson Memorial Chapter of the Leukemia Research Foundation, created in memory of my two-year-old daughter who died of leukemia in July 1981. Proud father of Ilyse Lee Gerson born July 1981." Our sympathies go out to Ira and his family.

Word from **Martin Brock**: "I haven't written in a while, but I've always read the column with interest. I'm enjoying living in Allston, next door to my good friend, **Geoff Garner**. I also enjoy being (sort of) near New York City.My graduate studies at M.I.T. continue along the lines of math and computers. I find it keeps getting more and more interesting. I would like to hear from **George Oparah**, **Emmanuel Bediako**, and **Richard Stone**!" . . . And from **Chris Garrod**: "Greetings from sunny southern California. I'm now well into my sixth year of grad school at Scripps Institution of Oceanography (my 23rd consecutive year in school). Finally passed my qualifying exam (same as comps) last summer. I'm still studying satellite oceanography and love it here." . . . And a last brief note: "**Tom Stohlman** and I (Katherine Malcolm Stohlman, '79) are living in Hingham, Mass., and working hard."

George Mabry was the guest speaker at the IEEE Management Society meeting last January. He discussed a technique he has developed for optimal choice of testing equipment, in terms of "capital equipment purchasing decisions and personnel utilization alternatives." George is in the employ of Teradyne as a product manager in the manufacturing systems division in Boston. . . . **Tom Martin** was our class representative at the Alumni Fund's fall telethon. The spring telethon is coming up May 10-13, and I hope some other '76ers in the Boston area will give Tom a hand. . . . Your secretary has had the pleasure of seeing **Erland van Lidth de Jeude**. He was in the midst of filming 20 days for the soap, "As the World Turns."Erland has also been called back for a second audition by the Metropolitan Opera Co. Quite a switch from soap opera!To facilitate his career, he has adopted a stage name, a shortened version of his full name, Erland van Lidth.

As for your secretary, the markets continue to have interesting behavior. Among the more noteworthy: heating oil, gold, treasury bonds and bills, soybeans, and Swiss francs. And the devaluation of the Mexican peso was fun to watch. However, this time, it was not accompanied by people jumping out of windows! Merrill Lynch is a very interesting place to work as well, especially as one of their senior analysts. I find it large, but not intimidating. The markets, on the other hand, can be frightening, especially interest rate futures.—**Arthur J. Carp**, Secretary, 15 Jones St., Apt. 3D, New York, NY 10014

77 5th Reunion

February has arrived with lots of mail from classmates, so here we go. . . . **Margaret Brandeau** received her M.S. in operations research from M.I.T. in February, 1978, worked for Arthur D. Little Co. for a year, then for Public Systems Evaluation in Cambridge for two-and-a-half years. Margaret is now at Stanford working on her Ph.D. in engineering-economic systems and is finding Stanford an enjoyable change. Her department also includes **Sam Holtzmann**, Jim Taul, '75, Dave Carino, '76, Bob Kenley, '75, and Prashant Parikh, '76. . . . **Steven Field** is working for duPont as a business analyst. Steven and his wife, Bonni, had a baby boy, John Paul, on November 9, 1981. . . . **Sterling Grant Brisbin, Jr.** married Mary Jenneskens on September 12, 1981. Sterling received his M.B.A. from Stanford; he and his wife now work for Bechtel Corp., and live in Tiburon, Calif. . . . **Barbara Belt** and her husband, Paul Erb, '76, are windsurfing every chance they get in Houston. Barbara is working for Shell Oil Co., Paul for Conoco. She misses Boston's character, but "it sure is nice having the sailing water stay liquid all year!"

Everett Butcher married Beverly Wieseman on June 19, 1981, and is now a senior analyst at Energy Engineering Associates, Inc. in St. Louis, Mo. . . . **Danny Bigio** has moved from Bogota to a "western type" town, Baranquilla, Colombia; he hopes to be back for our 5th reunion. . . . **Christopher Frey** was recently promoted to sales manager, Detroit territory, for a division of General Electric. . . . **Melvin Brown** married Annie Cooper in August 1980; they now have a daughter, Melannie Laura, born in June 1981. Melvin will be finishing his doctorate in physics at M.I.T. this June. . . . **Louis Bernstein** spent 1980 traveling in Asia and is now doing structural engineering for Raymond Tindahl, Inc. in San Francisco. . . . Having received his law degree and M.S. in public policy from the University of Michigan, **David L. DeBruin** spent the summer of 1981 traveling around Europe, camping and staying at hostels and with friends. David is now a law clerk in the U.S. District Court in Milwaukee, Wis. . . . **Steven Gourley** married Kristin Fidler on September 26, 1981. Ater a two-week honeymoon on Cape Cod, they settled into a new apartment and are still working for the Air Force—Steven is now a first lieutenant.

Daniel Higgins completed medical school in August 1980 and is now doing a surgical internship and residency at Graduate Hospital of Philadelphia. Dan notes that he recently attended the wedding of Arthur Wendell, '78, is "still single, and enjoyed the movie, *Stir Crazy*." . . . **Stephan Greene**, who has been with Pratt and Whitney for two years, is working on his M.B.A. at Hartford Graduate Center. Stephan has just become the alumni advisor for the Kappa Sigma chapter at the University of Connecticut. . . . **Timothy Waldron** married Kiki Babcock in June 1977 and moved to Syracuse, N.Y. where he works for General Electric. Tim and Kiki have a daughter, Kate, 3. After finishing the classwork for his master's in electrical engineering, Tim has avoided academics. Tim has seen few classmates since graduation but did visit **Charlie Briggs** at his "new/old house, suitable for a country squire." . . . **Daniel Gibson** is currently in the Ph.D. program at Johns Hopkins doing research on adaptation of the central auditory system of cats. . . . **Edward E. Eyler** will finish has Ph.D. in physics at Harvard in January 1982, and "unable to leave Cambridge after all these years," will stay on as a research associate. Edward will marry Karen Greer (Wellesley '78) in June 1982. . . . **Jonathan Green** has been doing work in high frequency acoustics. Jonathan says, "If science is on my side, I hope to finish my Ph.D. by June." Good luck, Jon!

Jeffrey Casper received his M.S. in physics from the University of Chicago, spent two years at Hughes Aircraft in Los Angeles, and is now with SRI International in Menlo Park, in their Electromagnetic Sciences Lab. Jeff had lots of news about classmates—he and **Steve Buchthal** attended the wedding of **Jed Fuhrman** and Dorothy Comeau in San Diego in August 1981. **Lester Weitman** and his wife, Corinne Asher, visited Jeff on their way to Hawaii; they managed to get in some winetasting in Napa Valley. . . . Our class was represented in the Alumni Fund's fall telethon by **Carol (Catalano) Martin** and **Esther Horwich**. Members of our class will be calling in the spring telethon, May 10-13. Let's try to really improve our gifts for our 5th Reunion!

I would like to thank those who have supported our 5th Reunion gift effort and joined the Class of '77 10's. They are as of March 1:

Gabriel A. Aeppli
Michael Atlas
Carlos R. Avecedo-Lucio
John Babiak
Steven R. Bader
William Baum
Robert W. Bechdolt
Brent A. Becker
Mark E. Beckham
Renan Beckman Wills
Philip O. Belanger
Albert D. Bigio
Clarence R. Blewett
Carlos H. Blohm
David S. Brody
Glenn W. Brown, Jr.
Steven W. Brown
Richard W. Buck
Earl H. Bunker
Craig A. Burch
Everett L. Butcher
William D. Byrne
Sergio D. Cabrera
Jeffrey E. Casper
Edward M. Cluss, Jr.
Michael C. Cohen
Libby Cone
Harish Dadoo
J. Mark Deric
Peter C. Doerschuk
John C. Doyle
Bruce E. Edwards
Richard M. Ehrlich
Solomon R. Eisenberg
Edward E. Eyler
C. Fernandez
David A. Fish
Darwin Fleischaker
Thomas A. Frank
Christopher R. Frey
Beth A. Ganister
Steven I. Ganzberg
Todd S. Glickman
Jonathan B. Goodman
Jonathan B. Green
Stephan A. Greene
Ralph E. Grismala
Debra Gross
J. Ernest Gross, III
Michael R. Gugenheim
David A. Gunter
Michael J. Haney
Leo P. Harten
Daniel R. Higgins
Brian G. R. Hughes
Darryl F. Jordan
Kenneth J. Klute, Jr.
Stewart J. Landers
Barbara H. Landreth
Stephen W. Lang

Kenneth J. Launie
Kenneth J. Lazarus
Daniel H. Leighton
Michael D. Lesh
Paul H. Levine
Alexander Ling, Jr.
Mark A. Long
Patrick T. Lopes
Manuel T. Lowenhaupt
David Y. Lu
Daniel S. Ludington
John B. Lundberg, Jr.
Robert H. Lustig
David M. Macklem
Theresa Madej
Carren L. McCarren
Charles E. McGinn
Kevin B. Miller
Paul J. Missel
Charles G. Mogged, Jr.
Craig C. Monsell
Philip C. Moore
William Morris
Paula L. Morse
Mark J. Neiman
Susan M. Nelson
Frederick J. Palmer
Michael A. Perfit
Henry P. Petrilli
Ronald C. Pirek
William E. Popp
Virginia P. Potter
Donald E. Rediker
Richard W. Reimer
Thomas R. Rhodes
James D. Richards, III
Jill A. Rhymes
W. M. K. Roddis
Lisa T. Rosenbaum
Mitchell J. Rothstein
Frederick M. Rust
Stephen M. Ryan
Alberto C. Sadun
Steven J. Schiff
Joseph M. Schneider
Matthew L. Sherman
Alan D. Siggia
Steven R. Sommer
Norman D. Speciner
Steven H. Spiro
Vincent P. Stanton, Jr.
Paul G. Steffes
Robert W. Stephens
Sue E. Stewart
Richard E. Stone
Thomas M. Strat
Jeffrey M. Swalchick
Dana A. Swann
Steven A. Swernofsky
Randall W. Terry
Scott E. Truesdell
Richard A. Ulene
Peter M. Van Doren
E. Van Lidth de Jeude
Mark C. Van Stolk
Robert S. Vincent
Timothy P. Waldron
James T. Walton
James Wang
David M. Wehrle
Leonard A. Wepasnick, Jr.
Andrew H. Werber
David R. Whitlock
Arthur L. Wilding-White
Leeson J. I. Winter
Thomas B. Wylegala
William T. Yeager

That's all for now—please do write. 'Til next month, bye.—**Barbara (Wilson) Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

78

On June 5, 1982, members of our class will be called upon to celebrate a momentous event—the fourth anniversary of our graduation from the all-emcompassing 'Tute. As you all know, the Alumni Association places great weight on participation in fourth-year reunion classes. To celebrate the occasion, there are tentative plans to organize a pub-stumbling tour, during which we will visit all the bars which used to be called "Fathers." For details, don't contact **Jim Bidigare** in Cambridge or **Steve Piet** in Boston.

As usual, this month's column is organized according to no particular theme. Let's start with **Lloyd Benjamin**, who just graduated from medical school this April. Two years ago I warned about our classmates in white coats—but Lloyd has outdone himself. He'll soon be starting residency in psychiatry at Western Psychiatric Institute at the University of Pittsburgh. Lloyd warns, "See ya on the couch, Bucko!" . . . More medical types. **Catherine Chiles** is also finishing up at medical school (UNCCH?) and will be doing her residency in psychiatry. . . . **Victor Villareal** is finishing up at Harvard Medical School in the HST program. At the time of this writing, he was waiting anxiously to hear about residencies. . . . **Miller Batson** and **Carl Hampf** are both finishing up at Duke Medical School. Carl did part of his rotations in New Zealand! . . . **Barry Linder** is well on his way to being our class's first space doctor. He's finishing his second year at Washington University Medical School in St. Louis, but he works summers at the Johnson Space Center in Houston, Tex. . . . Another medical classmate of ours in the news is **Roby Rosen**, soon a graduate of University of Pennsylvania Medical School. On May 30, Roby will be married to classmate **John Marcou**. An interesting note about this wedding is John's family history—his mother and father are both alums of M.I.T., met and married there. Also, John's brother George is M.I.T. Class of '79.

Love and marriage. Aside from Roby and John, weddings and engagements abound in our class. **Jennifer Jonas** and **John Starh** are tying the ol' knot this summer. Jennifer writes that she came back to work in Cambridge after getting her master's at Berkeley—she loves work in the real world. . . . **Pat Brown** and my old roommate, Tom "Touchdown" Davidson, '77, are getting married in a week and a-half (from the time of writing); I'll bring details in next issue. . . . **Sue Coppersmith** got married in December to Robert Blank. Sue is finishing up her Cornell Ph.D. thesis at Bell Labs in New Jersey. . . . **David Browne** will be getting married late this summer to Yuko Tukagi. David is working as an attorney in Boston and living in Cambridge. . . . **John McAleese** got married this past winter. (Sorry, I have no details.) . . . Rumor has it that **Al Chock** is getting married to longtime campanion Bonnie Mason, '79.

Anniversaries. **Diane Riker** and **Jim Hutchison** are about to celebrate their first anniversary. They were married on June 28, 1981; they're now living in Mountain View, Calif. Also married one year are **Naomi Johnson Miller** and David Miller, '79. They just bought a house in Oakland, Calif., half-a-mile from the Hayward Fault. . . . Marion and **Howard Katz** are approaching a year and a-half of marriage. Howard is finishing a Ph.D. in chemistry at the University of California at Los Angeles and is looking for a research position in the East. He and Marion have issued a challenge for the class mixed doubles tennis crown. . . . **Frank Chung** will celebrate his first anniversary of marriage to the former Sonhee Choi this September. Frank is now finishing up his M.B.A. at Stanford. . . . Another first anniversary—**Jill Kern** and Jeff Grossman, '76. Jill is in her first year at the University of Chicago's Business School. . . . And, in October **Fern Crandall DoVale** and husband Tony will celebrate their first year. Fern is working for Nuclear Power Services in Secaucus, N.J.

Change gears to boring post cards. **Paul Martin** has made a valiant effort with a series of terribly dull postcards from Europe and Middle America. Despite that, this month's crowning glory boring post card comes from **Susan Hansen**, titled "Wine Barrel Bung." What a find! I may have it framed. Susan is working in Boston at the Nutrition Department of the Cancer Research Institute of the New Angland Deaconess Hospital. (They have fold-out business cards.) She picked up the post card on vacation last summer, when she traveled California with **Penny Friedman**. Penny is finishing up her M.B.A. in Washington, D.C.

Esoteric Undertakings. **Dan Amidei** writes: "After a failed venture into gyroscopically stabilized hot air balloon production, I have returned to electron/positron annihilation as a vehicle for continued support.Preliminary measurements indicate that the tau lepton lifetime is too long. We are checking. . . ." (I offer $10 for a translation that a lawyer can understand.) . . . **Gary Cote** is "still working on how molds tell time." Apparently there are enough people working on this to hold conferences! Gary went to one last summer in Andover, N.H.—the "Gordon Conference on Chronobiology." . . . **Steve Norris** is working on a versatile, programmable, implantable nerve and muscle stimulator, which can be used to aid the operator of the heart, diaphragm, spinal chord, and for cerebral stimulation. Steve's a developmental biomedical engineer at Avery Laboratory in Farmingdale, N.Y. . . . As for me, I remain an underemployed attorney in Boston, looking for a change of job or a change of career.The big news in my life is. . .well, if you don't know it yet, you haven't been reading very carefully. So from me, sitting on a snow-covered winter's day, to you at the peak of spring, this is your secretary/treasurer.—**David S. Browne**, 148A Hancock St., Cambridge, MA 02139, (617) 491-5313

79

Hi there, classmates! Lots of gossip this month, so let's roll. **Paul Hoffman** has left Cambridge and is living "probably permanently, in Berkeley, Calif., and loving every minute of it." He is "an independent contractor, doing technical writing and (unfortunately) programming." . . . **Dan** and **Cathy Jaime** are finishing their second year with the army in Fort Bragg, N.C., where Dan has just recently moved to an assignment with a new unit and Cathy is enjoying her time at home with their three children. They encourage any classmates in the area to look them up for a brief visit or overnight stay. . . . **Norman Guivens** is a lieutenant in the Navy, currently stationed on the U.S.S. *Long Beach.* Norman is assigned to supervise the overhaul and testing operations of the No. 2 nuclear propulsion plant during the ship's complex overhaul at Puget Sound Naval Shipyard in Bremerton, Wash. He is enjoying the scenic beauty of the Pacific Northwest. . . . **Richelieu Hemphill** says congratulations to Sandra Jones, who graduated M.I.T. in December 1981.

David Geiser is a process design engineer for Monsanto in St. Louis. . . . **Gail Kaiser** was recently awarded the 1979 George E. Forsythe award by the Association for Computing Machinery for a paper she wrote while an undergrad at M.I.T. entitled, "Automatic Extension of an ATN Knowledge Base." The paper was published in the September 1981 issue of CACM and was based on Gail's S.B. thesis. (It's nice to know that *somebody* got *something* out of his/her thesis!). . . . **Harvey Cohn** worked for a year and a-half for a small architectural firm in Dallas, where he was active in the anti-nuclear movement there. He just returned from four months in Europe. . . . **James Rogers** finished his graduate degree at the 'Tute in August 1981, and started work with the Aerospace Corp. in Los Angeles in September. . . . **Paul Garvison** has been an engineer in photovoltaic systems research for Motorola for the last two years. . . . **Karl Kortepeter** is considering obtaining a slot in Air Force Undergraduate Pilot Training just to see if he can "get through its rigor." He says, "If I wash out, I'll be among the 60 percent who do. If I do succeed as a jet pilot, I will be among only 40 percent of the class who do!"

Jeffrey Bloch worked for a year and a-half at American Science and Engineering in Cambridge, developing image processing software for NASA's International Solar Polar Mission Spacecraft. In January 1981, he entered graduate school in physics at the University of Wisconsin, Madison. Last summer he had a research assistantship with the space physics group there, with which he hopes to do his thesis work. . . . **Helen Chihoski** works for Lamutt and Associates, a consulting engineering firm providing computer services to the engineering industry, in Englewood, Colo. Says Helen, "I love living in Denver—it seems that everyone from Colorado comes back! I'm also taking some courses at Conservative Baptist Theological Seminary and loving it. I guess once one has been in as demanding and exciting an academic envi-

ronment as M.I.T., one has got to keep going to school. I never thought I would continue studying but that's what I'm doing!" . . . **Rodney Burrows** is still working for a Department of Energy contractor in Amarillo, Tex., specializing in the design of explosion-resistant buildings. Rodney also bought some land on New Mexico's highest mountain, near Taos. "I am building a house out of salvaged trusses from a World War II bomb factory. The house is three plus stories (with level changes), all passive solar, built entirely from salvaged industrial scrap." . . . **Maury Scheck** is the associate marketing manager of the Los Angeles regional office of Atlantic Management Systems. "It's a great job," writes Maury, "with lots of room to grow and make mega-bucks! I'm having a blast enjoying the California girls (wish they all could be), and the hot-tubs!" He would like to hear from **John Fratamico**, **Denny Polla**, and **Shih Ming Shih**.

Ted Pounds has been commissioned a second lieutenant in the U.S. Air Force upon graduation from Officer Training School at Lackland Air Force Base in Texas. Selected for the school through a competitive exam, Ted will now go to Laughlin Air Force Base in Texas for pilot training. . . . **Richard Cook** is "living well" in Dayton, Ohio, and working for General Motors. Dick and **Martha "Red" Gallatin** will be married on May 30, 1982, and he is hoping that many lacrosse and SAE friends will come to help them celebrate. They plan to return to the Boston area permanently in 1983 after a four- to six-month vacation. Dick says "hi to all." . . . **Richard Byrne** is presently "drifting around in the world of LSI design in Milford, Conn., at ITT-Advanced Technology Center." He says, "So far I've been dabbling with various technologies such as CMOS and HMOS. Please extend my sympathies to all the M.I.T. students who are struggling to meet tuition (I know the feeling!). P.S. Are any of my Phi Delt pledge brothers still single? I'm not." . . . **Panayotis Cavoulacos** plans to complete his M.S. at the Sloan School in June 1982, then continue with a Ph.D. in nuclear engineering. (Sounds like a perpetual student to me!) Panayotis is a 1981-82 Henry Ford II Scholar at the Sloan School.

Carolyn Farley Maricq is still at Oxford doing a master's in management studies. Carolyn reports, "Oxford requires a completely different mode of thinking from M.I.T. So, between the two of them, I should be pretty versatile. I've gotten used to the British weather and enjoy being able to take off to Europe, although once or twice a year is not often enough. The degree I'm doing is a thesis degree—the thesis is the *only* item for evaluation. It's really hard to organize a project from absolutely nothing to completion. I've chosen a real mind-stretching topic: Differences in Conceptual Structure between Information System Designers and User-Managers. It's the old bridge the gap' strategy—the thesis is about it, and I hope to be doing it by writing the thesis. The rest of my life is running smoothly, in spite of the neglect of it due to thesis-writing!"

Ron Lyons is in Los Angeles (along with half the class!) working for Hughes Aircraft. He managed to find the time to do *Kiss Me Kate* and came away with something he hadn't planned on—a fiancee! Ron will marry Kathy Kearnes on July 10. Congratulations! . . . **David Soule** graduated from the 'Tute in February 1979 and started work as a mechanical engineer for Curtis Wright Corp. in New Jersey. Like many of us, David caught the M.B.A. bug and started as a night student at New York University Business School in September 1979. A year later, he became a full-time student and gave his leftover time to Curtis Wright as a consultant. Now, armed with the M.B.A. that he received last August, David is the manager of commercial development, chemicals, in the Europe/Mideast/African Division of American Cyanamid in Wayne, N.J. He recently got his own apartment in nearby Montclair, and he devotes some of his spare time to working lights for a local theatre group. . . . **Robert Tykulsker** is living and working in Cambridge as a transportation analyst for MultiSystems, Inc. . . . **Bruce Bornstein** represented our class in the Alumni Fund's fall telethon. **Brenda Hambleton** was the telethon coordinator for our class.

I've noticed a phenomenon that I feel has reached the level of tradition: namely, the presence of an M.I.T. alumna in the annual Wharton Follies. In 1979 it was Sandi Haber Sweeney, '78; in 1980 and 1981 it was yours truly; now, in 1982, it's Joan Solomon, '80. Keep it up!

Hope to hear from YOU soon.—**Sharon Lowenheim**, Secretary, 131 E. 83 St., Apt. 2G, New York, NY 10028

80

It is my unfortunate duty to report the death of **Jerome Kalmes**. Jerome, a member of the Pi Lambda Phi fraternity, died in an auto accident on October 25, 1981.

A recent note from **Ralph Hulseman** indicates that he has moved to Oakland, Calif., to pursue a Ph.D. in chemical engineering at the University of California at Berkeley.This comes on the heels of a one-year term that Ralph spent as assistant director of the M.I.T. Chemical Engineering Practice School in Oak Ridge, Tenn. . . . **Larysa Kulynych** is working on a Ph.D. in chemical engineering at M.I.T. and living in Somerville. . . . **Eric Balles** is working for Johnson Matthey, Inc. in Wayne, Pa., as an engine laboratory engineer, dedicated to the development of an automotive emission control catalyst. His girlfriend, **Susan Lee**, is working for Church and Dwight in Piscataway, N.J. as a process engineer. . . . **Paul Homsey** writes that he is enjoying his second year of medical school at the University of Texas in Houston.

At the recent Alumni Fund fall telethon, our class was represented by **David Cameron**, **Kenneth MacKillop**, **Gerald Eastman**, **William Butera**, **Charles Yie**, and myself. Charley, who happens to be our class agent, also won top-caller award for one of the evenings and led the way for the Class of '80 to win the coveted "Bronze Phone Award"! (Yes, that's right; remember that you heard it here first!)

Steven Struhl is in medical school in San Fransisco. . . . **Bill Springer** is at the University of Chicago working on his M.B.A. . . . **David Steffy** is at Hughes Aircraft in California. . . . **David Silberberg** is with Management Systems Division in Cincinnati. Of Cincinnati, David says that the winter is colder than Boston, and "not everyone looks like Loni Anderson." Sorry, Dave!

Michael Fink is working in the New York office of the general management consulting firm of Cresap, McCormick, and Paget. Mike will begin studying at the Stanford Business School in September. . . . **Nikhil Desai** is working on energy problems and policies in underdeveloped countries while working at the World Bank as a research assistant. . . . **Brent Dixon** has been busying himself getting his house together while patiently waiting for a normal ski season to begin. Looks like the waiting may have paid off this year, Brent! A large portion of his work involves NRC reviews.Brent also boasts an amazing garden from this preceeding summer.

And from **Darrell Hartwick**: "For any of you who were worried by the possibility that Digital was phasing out my job without providing me another, let me set the record straight. Actually, the old job was to become less general, so it was suggested that I use the opportunity to switch to what is now my job in the hopes I would gain design experience (for which I was trained). So far, the design work has been minimal, but I'm being patient. Coming back to the Institute for Choral Society rehearsals keeps bringing back memories."

Now comes the part of the column where I get to slip in some old friends. A recent, long-overdue conversation with **Mickey Lee** revealed that he just bought a house in Fremont, Calif. Mickey is working with semi-conductors for Hewlett Packard in Palo Alto, making LEDs and lasers. . . . Also out in California working for Hewlett Packard is **Richard Chin**, another friend from my days back in New House III. . . . Ex-roommate **Mike Greenwald** is working as a member of the staff of M.I.T.'s Lab for Computer Science and living in Somerville.

I've been enjoying the Boston winter, taking in a trip to M.I.T.'s Talbot House with my old living group, and watching everyone skid around in the Boston snow, while I truck along with my front-wheel drive. Nevertheless, I can see the hints of spring, and I find myself looking forward to it.How about if everyone out there sends me cards and letters to let me know what's happening outside the Boston area? The address is—**Ken Turkewitz**, Secretary, 3 Winslow Rd., Belmont, MA 02178, (617) 489-2441

81

When it rains, it pours! I heard from a lot of classmates over this past month. Keep up the good work. . . . **Jorge Herrera** writes to let all his friends know that he has survived his first term at Wharton. His major will be in financial management with an associate major in international business. Although Jorge seems to enjoy studying to be a corporate tycoon, he does miss Boston and M.I.T. . . . Received a press release from the University of Rochester: **Thomas Barta**, currently a Ph.D. candidate in the chemistry department there, has been awarded the 1981-82 Sherman Clarke Fellowship in chemistry. Sounds like Tom is mixing those chemicals just right. . . . Just "to show that not all of us went to M.I.T. to become rich engineers," **Linus Yamane** writes that he and **John Halikias** are doing graduate work at Yale "in the hope of becoming penniless academics." He says that Yale is treating them well. Linus recently spent a week skiing in Vail, Colo. with **Henry Neuman de Vegvar**, who is doing his graduate work in molecular biology at the University of Wisconsin at Madison.

All those who know **Richard Martin** from Delta Tau Delta should keep on the look out. Richard writes that he is currently a flight test engineer on the AV-8B program for McDonnell Douglas. He expects to move across the country several times before the program ends, so he hopes to get a chance to visit many M.I.T. friends. . . . **John Maciulewski** is presently working as the head teller in a Hartford bank. . . . **Victor Miller**, who was the first sutdent to complete the Engineering Internship Program, did his thesis with Hughes Aircraft Co. and is presently in the Systems Analysis Group at Loral Electronic Systems. . . . **Jay Napoleon** of Pi Lambda Phi fame is presently a first year medical student at the Medical College of Virginia in Richmond.

Well, our classmates do seem to be enjoying themselves and doing a lot of different things.—**Chuck Markham**, Secretary, 532 Beacon St., Boston, MA 02215

Sustaining Fellows

Life Members

1908
*Leo Loeb
*Mr. and Mrs. Harold S. Osborne

1912
*Dr. Jerome C. Hunsaker

1913
*Julian E. Adler
*Raymond B. Haynes

1914
*Mrs. Vashti L. Magoon

1915
*C. Ellis Ellicott, Jr.
*Mrs. Edmund R. Stearns
*Robert Welles

1916
*Mrs. J. B. Carr
*Ralph A. Fletcher
*Barnett D. Gordon
*Mrs. Francis E. Stern

1917
*Mr. and Mrs. Walter J. Beadle
*A. Raymond Brooks
*E. P. Brooks
*Stanley M. Lane
Mrs. Richard T. Lyons
*Mrs. William H. McAdams

1918
*Mr. and Mrs. Julian M. Avery
*Mrs. John W. Kilduff
Dr. and Mrs. Harold C. Weber

1919
*Benjamin H. Bristol
*Mr. and Mrs. Royden L. Burbank
*John L. Riegel
*Mr. and Mrs. Dean K. Webster, Jr.
*Lester Wolfe

1920
*Henry W. Hills
*Mr. and Mrs. Edwin D. Ryer
*Mr. L. G. L. Thomas

1921
Wallace T. Adams
*T. B. Davis
Sumner Hayward
*Irving D. Jakobson
*Samuel E. Lunden
*Robert L. Moore
*Mr. and Mrs. Antonio Helier Rodriguez
*Mrs. Raymond A. St. Laurent
*Mrs. Arthur G. Wakeman
Mr. and Mrs. Robert E. Waterman

1922
*Mr. and Mrs. Edward L. Bowles
*Donald F. Carpenter
*Whitworth Ferguson
*Crawford H. Greenewalt
*Mr. Oscar H. and Mrs. Mary C. Horovitz
*Mr. and Mrs. Albert J. R. Houston
*Mr. H. W. and Mrs. S. Catharine McCurdy
*Theodore T. Miller
*Mr. and Mrs. Thomas H. West

1923
*Mr. and Mrs. Jonathan Y. Ballard
*Mrs. Philip L. Coleman
*Dr. and Mrs. Cecil H. Green
Earle A. Griswold
Mr. and Mrs. Harry Kalker
*Mr. Ragnar D. and Mrs. Margaret Naess
*Alfred E. Perlman
*Mrs. David W. Skinner
*Mr. and Mrs. Robert C. Sprague
*Dr. and Mrs. Julius A. Stratton
Chaplin Tyler
*Mrs.Uncas A. Whitaker

1924
*Gordon Y. Billard
*Mr. and Mrs. Philip D. Blanchard
*Mr. and Mrs. Austin G. Cooley
*Luis A. Ferre
*Mrs. Harold L. Hazen
*Mrs. Edward J. Hanley
*Mrs. Andrew P. Kellogg
*Paul Tishman

1925
*Marion W. Boyer
*John M. Campbell
Mr. Edward H. deConingh
*Mr. and Mrs. Frederick W. Greer
Mr. Edward M. Lee
*Mr. and Mrs. Samuel R. Spiker
*Mr. and Mrs. Karl R. Van Tassel

1926
*Mr. and Mrs.Robert T. Dawes
*Mr. and Mrs. William E. P. Doelger
*George P. Edmonds
*Mr. and Mrs. Eben B. Haskell
*I. Austin Kelly III
*Dr. and Mrs. J. R. Killian, Jr.
*John R. Kimberly
*Mr. and Mrs. George J. Leness
*Thornton W. Owen
*Mr. and Mrs. Wm. Crighton Sessions
*Mr. David A. Shepard
*Mrs. George Warren Smith
*Mr. and Mrs. James P. Warner
*Mr. and Mrs. John B. Wright

1927
*S. S. Auchincloss
*Arthur J. Connell
Mr.and Mrs. Arthur G. Connolly
Dr. and Mrs. Harold E. Edgerton
*Mr. and Mrs. Harold W. Fisher
Mr. and Mrs. Thomas A. Knowles
*John W. Norris, Sr.
*Howard W. Page
*Russell P. Westerhoff
*Mr. and Mrs. Clarence L. Wynd

1928
*Homer A. Burnell
Mr. and Mrs. Roland D. Earle
*Mr. and Mrs. Tom Garrard
*Elisha Gray II
*Mr. and Mrs. Henry N. LaCroix
*Carl M. Loeb, Jr.
*Mrs. Edward J. Poitras
*Mr. and Mrs. Walter J. Smith
*Mr. and Mrs. Abraham Woolf

1929
*David F. Bremner
*Mr. J. Russell and Mrs. Dorothy V. Clark
*Harry F. Dickinson
*Walter H. Gale
*Mr. and Mrs. Dexter T. Osgood
*John J. Wilson

1930
*Alan C. Bemis
*Mrs. Ernest B. Dane
*Mr. and Mrs. Allen Latham, Jr.
*Gordon K. Lister
W. Wallace McDowell
*Walter W. Soroka
Mr. and Mrs. Richard M. Wilson
Ching T. Yang

1931
*David W. Bernstein
*Dr. and Mrs. Gordon S. Brown
*George M. Bunker
*Mr. and Mrs. Emilio G. Collado
*Daniel S. Connelly
*Mrs. James B. Fisk
*Mr. and Mrs. Kenneth J. Germeshausen
*J. K. Jamieson
*Mr. and Mrs. Claude F. Machen
*Dr. and Mrs. Donald B. Sinclair
Harold M. Wilson

1932
*Bennett Archambault
*Mr. Cecil Boling
Mr. and Mrs. Howard F. Carver
*Mr. and Mrs. Alexander D. Daunis
*John Navas
*Mr. and Mrs. Eric P. Newman
*Robert B. Semple
*Charles C. Wyatt

1933
*Dr. and Mrs. Dayton H. Clewell
*Mr. Ralph and Mrs. Eloise Cross
*Pierre S. du Pont
*Herbert E. Grier
*Mr. and Mrs. Cyrus S. Hapgood
*Warren J. Henderson
Mr. and Mrs. George Henning
*Mr. and Mrs.C. D. Marshall
*Mr. and Mrs. Malvin J. Mayer
*Richard S. Morse
Mr. and Mrs. Harris A. Thompson
*James E. Turner

1934
*Samuel A. Groves
Mr. and Mrs. Albert A. Hopeman, Jr.
Donald K. Lister
*Frank R. Milliken
*William H. Mills
*Richard H. Sanders

1935
*Mr. and Mrs. Leo M. Beckwith
*Hal L. Bemis
*Wesley H. Loomis III
*Mr. and Mrs. John F. Taplin
*Max Wasserman

1936
*Mrs. William W. Garth, Jr.
*Mr. and Mrs. Henry F. Lippitt, 2nd
Mr. and Mrs. G. Elliott Robinson
*Mr. and Mrs. Louis E. Stahl

1937
*Mr. Paul W. Allen
*Mr. and Mrs. W. B. Bergen
*Alanson W. Chandler
*Ralph B. Chapin
*Mr. and Mrs. Robert Cloud
*George S. DeArment
*James M. Ewell
*Mr. and Mrs. Herbert F. Goodwin
*William E. Hartmann
*Joseph F. Keithley
*Mr. and Mrs. William J. McCune, Jr.
*August H. Schilling

1938
Peter de Florez
*Mr. and Mrs. Haskell R. Gordon
*Mr. and Mrs. Norman B. Leventhal
James C. Longwell
*Cornelius Van S. Roosevelt
*Mr. and Mrs. David A. Wright
*St. Clair P. Yates

1939
*Leonard and Arlene G. Mautner
*Mr. and Mrs. Harold J. Muckley
*Mr. and Mrs. Harold R. Seykota

1940
Thomas F. Creamer
*Mr. and Mrs. W. Kenneth Davis
W. H. Krome George
I. M. Pei
*Dr. and Mrs. Karl Pfister
*Mr. and Mrs. Edwin H. Seim

1941
*Daniel F. Flowers
*Fred Fort Flowers

*Joseph G. Gavin, Jr.
E. Kirkbride Miller
*Mr. and Mrs. Carl M. Mueller
*D. R. Weedon, Jr.
*Mr. and Mrs. Frank S. Wyle

1942
*Frederick M. Dierks
*Mr. and Mrs. Morton E. Goulder
*Mr. and Mrs. Floyd A. Lyon
Lee and Geraldine Martin
*Jonathan H. Noyes
Mr. Edward L. Pepper
*Mr. and Mrs. Edward O. Vetter

1943
*Mr. and Mrs. J. Robert Gunther
*Rudolph Hurwich
Mr. and Mrs. Christian J. Matthew
*Mr. and Mrs. Walter A. Netsch
*Mr. and Mrs. Stanley M. Proctor
*S. James Spitz, Jr.

1944
*Robert E. Meyerhoff
*Eric M. Wunsch

1945
*James A. Levitan
*Emily V. and Jeptha H. Wade

1946
*Mr. and Mrs. Donald E. Burke
*Angus N. MacDonald
*Roger and Joan Sonnabend
*Mr. James L. and Mrs. Faith P. Waters

1947
Mr. and Mrs. Paul M. Cook
*Philip R. Jonsson
*Mr. and Mrs. Bernard G. Palitz
*Mary F. P. Wagley

1948
*Lester R. Ackerman
*E. Rudge Allen
*Bernard M. Gordon
*E. W. Hiam
*Dr. and Mrs. Alan F. Kay
*Lois and Philip Macht
*Denman K. McNear
*Peter Saint Germain
*Mr. and Mrs. C. Vincent Vappi
*Mr. and Mrs. William J. Weisz
*William R. Zimmerman

1949
Mr. and Mrs. George F. Clements, Jr.
Ge Yao Chu
*Bradford M. Endicott
*George N. Hatsopoulos
*Mr. John W. and Mrs. Geraldine S. Kunstadter
*Mr. and Mrs. Jack C. Tang

1950
*Kenneth H. Olsen
*William D. Walther

1951
*Breene M. Kerr
*Dr. and Mrs. Anthony D. Kurtz
Mr. and Mrs. Albert Zesiger

1952
*Dr. Yaichi and Mrs. Masako Ayukawa
*Mr. and Mrs. Herbert H. Dow
*Mr. Ernest A. Grunsfeld III

1953
Mr. and Mrs. Frederick R. Cronin
Mr. and Mrs. James D. Kolb
*Martin Wohl

1954
*Mr. and Mrs. James J. Baker
*Ronald A. Kurtz

1955
*Jean Montagu

1956
Mr. and Mrs. Michael Schiller

1957
*Charles G. Koch
Dr. and Mrs. Leslie M. Orloff

1959
Albert P. Hinckley, Jr.
Robert A. Muh

1960
*Fred Kayne

1961
*Mr. and Mrs. John S. Reed

1962
*David H. Koch
*William I. Koch

1966
*Paul Rudovsky

1967
*Charles Ying

1968
*Richard Ying

1969
Mr. and Mrs. Robert A. Swanson

1972
*Mr. and Mrs. Terrence A. Tobias

Aeronautics and Astronautics
*Dr. and Mrs. Yao Tzu Li '38

Architecture
*Armand Bartos '35

Chemical Engineering
*Mrs. Edwin R. Gilliland '33
*Robert C. Gunness '34
*John C. Haas '42
*C. J. Harrington '38
*Dr. and Mrs. Ralph Landau '41
*Jan W. Mares '60
*Charles B. McCoy '32
*Ralph D. Patch '32
*Charles E. Reed '37
*Arch C. Scurlock '43
*George R.Vila '33

Chemistry
*Dr. Robert G. and Mrs. Alma S. Breckenridge '42
*Howard S. Turner '36

Civil Engineering
*James G. McCurdy '48

Earth and Planetary Sciences
*Dr. and Mrs. Louis Berger '40

Economics
Dr. and Mrs. Thomas Marill '56

Electrical Engineering
*Mr. and Mrs. Abraham Dranetz '48
*John M. Fluke '36
*William R. Hewlett '36
*Dr. and Mrs. David I. Kosowsky '52
*Douglas T. Ross '54
*Professor and Mrs. John G. Trump '33

Management
Mr. Fred and Mrs. D'Maris Mangelsdorf '60
Mr. and Mrs. Martin Y. Tang '72

Materials Science and Engineering
*Dr.and Mrs. Phillip Hartley Smith '52
Mr. and Mrs. John A. Stern '41

Mechanical Engineering
*Mr. Philippe and Mrs. Katherine Villers '60

Meteorology
*Dr. and Mrs. Norman E. Gaut '64

Physics
*Dr. and Mrs. Colgate W. Darden III '59
*Otto Morningstar '39

Senior Executives Program
Dr. and Mrs. Cuthbert C. Hurd '59

*Sloan Fellows Program
*Mr. and Mrs. Marshall Wren Gabel '39
*Mr. and Mrs. Wayne J. Holman, Jr. '39
Mr. and Mrs. Charles E. Wampler '40
*Mr. and Mrs. T. A. Wilson '53

Urban Studies and Planning
*Dr. and Mrs. Alan M. Voorhees '49
*W. Maurice Young '61

Honorary
*Mr. and Mrs. Howard W. Johnson
*Mrs. Conchita Z. Lobdell Pearson
*Dr. and Mrs. Jerome B. Wiesner

Founding Annual Members

1908
*Mr. and Mrs. Franklin T. Towle

1912
*Mrs. John W. Connolly

1914
Charles H. Chatfield

1922
Miss. Marjorie Pierce

1923
Mr. and Mrs. Joel Y. Lund

1924
Mr. and Mrs. Edward A. Abdun-Nur

1925
*Donaldson F. Jones
Mr. and Mrs. Edwin Kussmaul
Mrs. Avery H. Stanton

1928
Mr. and Mrs. George P. Palo

1929
*Seymour A. Baum
*Warren W. Walker

1930
Bartholomeo DeLorenzo
*Robert B. Rypinski
Myron T. Smith

1931
Mr. and Mrs. David V. Buchanan
Mr. and Mrs. J. Franklin Cook
Dr. and Mrs. Norman D. Fitzgerald
Mr. and Mrs. Richard T. Kropf
Mr. and Mrs. Myrle M. Perkins
*Spencer S. Prentiss

1932
*John J. Brown
Dr. Albert G. H. and Mrs. Ruth A. Dietz
Dr. and Mrs. Rolf Eliassen
Mr. and Mrs. Gaynor H. Langsdorf

1933
Mr. and Mrs. Frank J. Bleil
*Frederick V. Murphy, Jr.

1934
Richard Bell
Mr. and Mrs. Thomas M. Burton
Mr. and Mrs. James Eder
Samuel Untermyer

1935
Charles N. Debes

1936
Mr. and Mrs. Ford M. Boulware
*James H. Grove

1937
*Alfred E. Busch
P. H. Dreissigacker

1938
*John B. McCrery
*Mr. and Mrs. W. Shamban

1939
Richard J. Donohoe
*Mr. and Mrs. Charles S. Mercer

1940
*John J. Casey
*Robert K. Deutsch
*Professor and Mrs. Samuel A. Goldblith
*N. R. Klivans
*E. M. Wallace
H. Garrett Wright

1941
Merlyn J. Block
Mr. and Mrs. James F. Healey
*Mr. and Mrs. Edward R. Marden
*Mr. and Mrs. Clifford E. Moffet
*Arthur S. Spear

1942
*Mr. and Mrs. David M. Baltimore
*Donald C. Berkey
*Mr. and Mrs. Albert F. Clear, Jr.
*Jerome T. Coe
*James K. Littwitz
*Mr. and Mrs. F. Richard Meyer III
Mr. and Mrs. Warren W. Twaddle
Leopold S.Wyler

1943
*Earl L. Bimson
*Charles Chubb
Mr. and Mrs. Arthur Vershbow

1944
*John A. Lednicky
*Thornton Stearns
*Mr. and Mrs. Paul K. Tchang
*Mr. and Mrs. Stanley W. Warshaw

1945
Hector M. Orozco
Mr. and Mrs. J. Spencer Standish

1946
Mr. and Mrs. David G. Black Jr.
Mr. and Mrs. Carroll J. Brown
*Mr. and Mrs. S. James Goldstein
Mr. and Mrs. Herbert J. Hansell

1947
*Harl P. Aldrich, Jr.
Edward E. David, Jr.

1948
Mr. and Mrs. D. Dennis Allegretti
*Nichols W. Caldwell
*Carl Hilton
*George M. Keller
*Warren J. King
Mr. and Mrs. John W. Weil

1949
E. Milton and Paula Lawton Bevington
*Mr. and Mrs. Leonard Bezark, Jr.
*Alexander d'Arbeloff
Mr. and Mrs. William C. Howlett
*Karl F. Kirchner
*William P. Reynolds, Sr.
Mr. and Mrs. David Tod

1950
Dr. and Mrs. Edward S. Cohen
Mr. and Mrs. M.G. Hulme, Jr.
*Mr. and Mrs. Robert W. Mann
*Mr. and Mrs. Harry Tecklenburg

1951
*Nick F. Badami
Mr. and Mrs. David A. Bossen
*Marvin Grossman
Mr. and Mrs. Frank E. Heart
*Walter Rajki

1952
*Irwin J. Grossman
*Mr. and Mrs. James R. Reese

1953
*Gunther W. Balz
Mr. and Mrs. R. P. Simmons

1954
*Robert H. Brown, Jr.
*Alex W. Dreyfoos, Jr.
Armando Garza Sada
*Dr. and Mrs. Paul E. Gray

1955
*John Buchanan Brown
*George P. Edmonds, Jr.
*Dr. and Mrs. Russell G. Meyerand, Jr.
*DuWayne J. Peterson, Jr.
*L. Dennis Shapiro
*James W. Storey

1956
Mr. C. Gordon Bell
Mr. R. Gordon Black
*Roger and Brenda Borovoy
Mr. and Mrs. Joseph S. Gaziano
Regis W. Schultis, Jr.
Jerome E. Vielehr
Dr. and Mrs. Andrew J. Viterbi
Mr. and Mrs. Harris Weinstein

1957
*Harry B. Duane
Dr. and Mrs. Irwin Mark Jacobs
Elliot K. Wolk

1958
Charles Diebold III
*Sanford M. Nobel
Mr. and Mrs. James Simons
Glenn P. Strehle

1959
H. H. Champlin
*David J. McGrath, Jr.
Carlos Prieto
Lawrence G. Roberts

1961
*Richard B. Slifka

1962
David S. Y. Wong

1963
Mr. and Mrs. Roland B. Butterfield, Jr.
*John K. Castle
*Mr. and Mrs.L. Robert Johnson

1964
Robert L. Blumberg

1965
Mr. and Mrs. James W. Taylor

1967
*Mr. and Mrs. Loughrey R. Kuhn

1970
*Charles L. Housman

Aeronautics and Astronautics
*Dr. and Mrs. Robert C. Seamans, Jr. '42

Chemical Engineering
*Professor and Mrs. Raymond F. Baddour '49
*Mr. and Mrs. Vernon O. Bowles '33
*Mr. and Mrs. David Brown '40
*Dr. and Mrs. Joseph Byrne '50
*Jerry A. Cogan, Jr. '58
John P. Longwell '43
*Robert L. Mitchell '47
Mr. and Mrs. C.K. Walker '40

Chemistry
*Mr. Edward R. Kane '43

Civil Engineering
*Ernst Basler '57
Roy W. Carlson '39
Robert L. Daniels '66

Electrical Engineering
Dr. Jerrold A. Heller '64
Dr. and Mrs. Leo Jedynak '56
*Mr. and Mrs. Ben V. Thompson '38

Management
*Philip R. Marsilius '48
Ms. Norna Sarofim '72

Ocean Engineering
Victor K. Atkins '47
Mr. Guy and Mrs. Francoise Viellet '50

Sloan Fellows Program
*O. C. Boileau '64
*Robert F. Calman '67
Mr. and Mrs. Chester W. Diercks, Jr. '62
*R. C. Ernest '59
Arthur J. Hedge, Jr. '73
*Wylie S. Robson '56
*Mr. and Mrs. Neal O. Wade, Jr. '56

Non-Alumni M.I.T. Sustaining Fellows
***Founding Life and Life Members**
*Mr. David F. Austin n/a
Mrs. Quentin Berg n/a
*Dr. Peter S. Bing n/a
*Mrs. Thomas D'Arcy Brophy n/a
Mr. and Mrs. William A. M. Burden n/a
*Mr. and Mrs. John H. Bush n/a
*Mr. Louis W. Cabot n/a
*Mr. and Mrs. Thomas D. Cabot n/a
*Mr. Frank T. Cary n/a
*Mr. and Mrs. A.H. Chatfield, Jr. n/a
*Mr. Landon T. Clay n/a
*Mr. Randolph P. Compton n/a
*Mr. William A. Coolidge n/a
*Mr. Douglas Drane n/a
*Mr. Willis H. duPont n/a
Mrs. Priscilla Maxwell Endiott n/a
*Mr. Robert E. Firmenich n/a
*Mrs. Henry W. Gadsden n/a
*Mr. Robert W. Galvin n/a
*Mr. and Mrs. George P. Gardner, Jr. n/a
*Dr. Anthony H. Gleason n/a
*Mrs. Jacob A. Goldfarb n/a
*Ms. Marion Hanny n/a
*Mr. Richard A. Herman n/a
*Mr. Samuel C. Johnson n/a
*Mr. and Mrs. J. E. Jonsson n/a
*The Aga Khan n/a
*Betty and Max Kranzberg n/a
*Mr. and Mrs. William S. Lasdon n/a
*Mr. Edmund W. Littlefield n/a
Miss Gladys F. MacDonald n/a
*Mr. Henry J. McCarthy n/a
*Mrs. Eugene M. McDermott n/a
*Mr. J. Irwin Miller n/a
*Mr. Francis L. Moseley n/a
*Mr. and Mrs. W.B. Murphy n/a
*Mr. William H. Nichols, Jr. n/a
Dr. and Mrs. Daniel Orloff n/a
*Mr. Milan Panic n/a
*Mr. and Mrs. Saul Poliak n/a
*Mr. Laurance S. Rockefeller n/a
Mrs. Agnes Saalfield n/a
*Mr. Louis E. Seley n/a
*Mr. and Mrs. C. Maxwell Stanley n/a
*Mr. and Mrs. Lauson H. Stone n/a
*Dr. and Mrs. Jerome B. Wiesner n/a
*Drs. Jerrold R. and Leona Zacharias n/a
*Dr. Alejandro Zaffaroni n/a

Non-Alumni M.I.T. Sustaining Fellows
***Founding Annual and Annual Members**

*Dr. and Mrs. Robert A. Alberty n/a
*Mr. S. D. Bechtel, Jr. n/a
Mr. Kirk F. Blanchard n/a
*Mr. C. Lester Hogan n/a
Mr. G. F. Jewett, Jr. n/a
Mrs. David Karp n/a
*Mr. Bernard J. O'Keefe n/a
*Dr. Thomas O. Paine n/a
Dr. Peter H. Stone n/a

Courses



Nearly 70 friends and colleagues gathered in February to honor Edwin E. Kintner, S.M.'46, on his resignation from federal service as director of the Department of Energy's Office of Fusion Energy. Left to right: Robert C. Gooding, S.M.'46; Professor Herman Feshbach, Ph.D.'43, head of the Department of Physics; Mr. Kintner; Professor Neil E. Todreas, Sc.D.'66, head of the Department of Nuclear Engineering; Professor Francis E. Low, provost; and Professor Ronald C. Davidson, director of the M.I.T. Plasma Fusion Center. (Photo: Calvin Campbell)

I
Civil Engineering

Melvin R. Rubin, S.M.'51, is currently a data analyst in the reliability department at the Raytheon-Lowell, Mass., production plant. . . . **Thomas S. Maddock,** S.M.'51, writes, "I have been promoted to rear admiral, Civil Engineer Corps, U.S. Naval Reserve, holding a mobilization billet as Deputy Chief of Staff for construction management, for the Commander-In-Chief, U.S. Naval forces, Europe. I am also assigned as Director of the Naval Reserve Facilities Engineering Program, in command of units which augment naval facilities engineering command on mobilization. I am also still the president of Boyle Engineering Corp., headquartered in Irvine, Calif."

Cranston R. Rogers, S.M.'51, writes, "I have recently taken a position as manager of transportion planning and design with the constructing firm of Turner, Collie and Branden, Inc., Houston, Tex. Our projects include some of very needed improvements to Houston's highway and arterial street systems." . . . **Norman R. Rosen,** S.M.'54, reports that he has been appointed vice-president of project management of A. Epstein and Sons, Chicago, Ill. He recently completed a position as director of special projects for the city and county of San Francisco, Calif. . . . **Harold G. Lorsch,** S.M.'42, writes, "I have been working on solar energy research, development, and economics for the past 11 years; first at the University of Pennsylvania, and presently at the Franklin Institute in Philadelphia. We have quite a few M.I.T. alumni at this institution—nuclear engineers, physicists, and electrical engineers."

Douglas H. Merkle, Ph.D.'71, writes, "I am a senior engineer and head of the Structures Group at Applied Research Associates, Inc., Albuquerque, N.M. The firm specializes in the effects of earthquakes and explosions on structured systems." . . . **John F. O'Leary,** S.M.'66, has been promoted to manager, Division Procurement for the San Francisco Power Division of Bechtel Power Corp. . . . **Joseph J. Rixner,** S.M.'68, writes, "I have recently assumed position of manager of H&A, Rochester, N.Y., an affiliate of Haley & Aldrich, Inc., Cambridge, Mass., a consulting and geotechnical engineering firm with whom I have been employed for 12 years. I am an associate and vice-president of Haley & Aldrich, Inc."

Gino J. Baroni, S.M.'80, writes, "I am assistant to the president/construction coordinator for Beacon Construction Co., Inc., an affiliate of the Beacon Companies, investment builders, Boston, Mass." . . . **Thomas Asselin,** S.M.'66, is currently a senior partner in the Atlanta law firm of Peterson, Young, & Asselin, which specializes in construction and engineering law as well as dealing with public contracts.

Edgar F. Davis, S.M.'63, of Berkeley, Calif., passed away on November 14, 1981; no details are available. . . . **George F. Meyer,** '41, of Columbia, S.C., passed away on July 4, 1980; no details are available.

III
Materials Science and Engineering

Arden L. Bement, formerly a member of the faculty in materials science and engineering who is now vice-president for technical resources, science, and technology at TRW, Inc., of Cleveland, Ohio, returned to M.I.T. late in the winter with a happy purpose: to present TRW's gift for continued support of research at M.I.T. through the Industrial Liasion Program.

Professor John F. Elliott, Sc.D.'49, who heads the Mining and Minerals Resources Institute at M.I.T., is one of the two first recipients of the Distinguished Professor Award of the American Iron and Steel Institute. The award honors "long-term exceptional contributions to the iron and steel industry," and Professor Elliott will be recognized for the award at the American Iron and Steel Institute's annual meeting in New York next month.

Jerry E. Turnbaugh, Sc.D.'62, is one of nine named by Oregon Governor Vic Aticyh to serve a two-year term to the new state Advisory Council on Occupational Safety and Health. Duties include "submitting to the governor and to the Legislature an annual report covering the activities of the state Workers Compensation Department with regard to occupational safety and health programs." . . . **Italo S. Servi,** Sc.D.'49, reports that he has retired from Kennecott Corp., and is now active in a technical and management consulting practice. . . . **Robin Stevenson,** Ph.D.'72, has been named to the staff at Lawrence Institute of Technology, Southfield, Mich., as a lecturer in the School of Engineering.

IV
Architecture

Gyorgy Kepes, Institute Professor Emeritus, now holds the Distinguished Teaching Award of the College Art Association of America. He was cited for "the most profound influence on perception studies and visual theory teaching. Your researchers have generated lasting impact on the foundation and design training of American art students," said the citation.

Henry S. Plummer, M.Arch.'75, has been appointed an assistant professor of architecture at the University of Illinois, Urbana-Champaign. Formerly he has been an architectural designer with Warner-Burns-Toan-Lund, New York City, since 1977. . . . **Robert A. Deshon,** M.Arch.'40, reports that he has been retired since June 1980.

V
Chemistry

Howard H. Rogers, Ph.D.'53, is currently a senior scientist at Hughes Aircraft. . . . **Eugene A. Burns,** Ph.D.'56, writes, "This year I became vice-president of Systems, Science and Software, in charge of the Chemistry and Chemical Engineering Group." . . . **Stephen A. Monti,** Ph.D.'64, is cur-

rently Professor of Chemistry and Associate Vice-President for Academic Planning at the University of Texas, Austin. . . . **Neil R. Andersen,** Ph.D.'65, has been appointed by the State Department to a senior position with the United Nations in Paris. Working for the Intergovernmental Oceanographic Commission, he will be responsible for studies in marine pollution.

Robert A. Lefever, Ph.D.'53, has been recently promoted to Production Manager, Ferritte Memory Core Plant, Ampex Corp., and has been a recent contributor to the Landolt-Bornstein reference series on science and technology. . . . **Mark Engler,** Ph.D.'69, is presently supervisor of oncology physics and assistant professor of radiology at Duke University Medical Center, Durham, N.C. . . . **Arthur S. Obermayer,** Ph.D.'56, reports, "During the past year I have been elected chairman of the Northeastern section of the American Chemical Society and have been appointed to the National Science Foundation Advisory Council and the Senate Small Business Committee National Advisory Council." . . . **Edward S. Macias,** Ph.D.'70, Associate Professor of Chemistry at Washington University was named Acting Director of their Summer School (on January 1, 1982), responsible for planning its future development.

Gregory A. Rupprecht, Ph.D.'79, of Roselle, N.J., passed away on August 30, 1980; no details are available.

VI-A Program

A total of 178 applications were received to fill the 85-90 openings available in this year's 65th VI-A class. Fifty-four percent of this year's Course VI sophomores applied for the program, indicating that VI-A is still much in demand and well accepted by the students. Although down in total numbers from last year, this is a one percent increase from the Class of 1984 over 1983; the E.E. & C.S. Class of 1984 is 9.9 percent smaller than its predecessor. Although the participating companies would like to take more new students, the department is limiting the size of the incoming class for the second of three years to match the load the current faculty can handle.

Analog Devices, Inc., joined the program this year. Representing them at the March Annual Business Meeting, Dinner and Company open House was **A. Graham Sterling, Jr.,** '48.

A sizeable number of other alumni/ae also represented their firms for the annual gathering and assisted with the total of 916 student interviews conducted during the two days of March 2nd and 3rd. A partial listing of them is: **Lawrence W. Banks,** '67, Hewlett-Packard Medical Group; **Thomas L. Bentley,** '73, Hewlett-Packard Computer Group; **H. Elmore Blanton,** '49, Raytheon Co.; **Donna B. Bourgelais,** '70 (formerly Northam), AVCO-Everett Research Labs.; **W. Sumner Brown,** '66, C.S. Draper Laboratory; **Geoffrey J. Bunza,** '74, GenRad, Inc.; **Dean R. Collins,** '58, Texas Instruments, Inc.; **Scott E. Cutler,** '72, G.E. Corporate Research Laboratories; **Terry A. Dorschner,** '65, Raytheon Co.; **R. Ellis DuPuy, Jr.,** '74, Tektronix, Inc.; **Delmer L. Fehrs,** '63, Tektronix, Inc.; **Joel A. Feldman,** '79, Lincoln Laboratory; **Robert M. Fiorenza,** '62, IBM Corp. General Technology Division; **Jeffrey T. Millman,** '71, Lincoln Laboratory; **Victor L. Ransom,** '48, Bell Laboratories, Inc.; **Robert G. Rullman,** '51, Tektronix, Inc., **David M. Ryter,** '80, Codex Corp.; **Daniel M. Sable,** '80, RCA Astro Division; **William G. Scott,** '79, Naval Surface Weapons Center; **Ernst Schloemann,** '55, Raytheon Co.; **Kenneth A. Van Bree,** '71, Hewlett-Packard Laboratories; **Kurt A. Vanlehn,** '78, Xerox Corp./Palo Alto Research Center; and **Jill J. Wittels,** '70, Honeywell Electro-Optics Center.

Emeritus Professor **Karl L. Wildes,** '22, tells us he received a call from **Albert J. Carey,** '28, who was wintering in Florida. Mr. Carey was with the first group of students to partake of the Bell System option when it became available in VI-A.

Spending five days at the Colonial Hilton, Wakefield, Mass., taking a computer course on behalf of Dolby Laboratories which he has recently joined was **John F. Cooper,** '74. John and wife Dea then left for two weeks in London—one on vacation, the other on business—before returning to their home in Palo Alto, Calif.

Also spending four days in Boston as part of a vacation the second week in March was **Edward C. Giaimo III,** '74. Ed is now located in Seattle, WA and works for Data I/O, Inc., in Redmont, WA.

Director Tucker had a very pleasant afternoon's visit from **John G. Linvill,** '43. John was at M.I.T. attending the department's Centennial Workshop in January. He is at Stanford University where he served as E.E. department head for some years.

We're always very fortunate in seeing a lot of visitors in the VI-A office. Since our last article the following VI-A alumni/nae have come by (in addition to those mentioned above): **John F. Buford,** '81, associate eengineer with IBM Corporation, Endicott, N.Y.; **Ludek Dadok,** '80, just finishing his VI-A work with Hewlett-Packard Laboratories, Palo Alto, Calif.; **Chester M. Day, Jr.,** '57, with Satellite Business Systems, McClean, Va.; **David W. Duehren,** '80, an engineer with Motorola, Austin, Tex.; **Holton E. Harris,** '44, whose son Walter has received early admission to M.I.T. for September 1982, Westport, Conn.; **Jeffrey J. Jaycox,** '80, design engineer with Texas Instruments, Inc., Dallas, Tex.; **Charles A. Kaminski, Jr.,** '70, vice-president of marketing, Creare Innovation, Hanover, N.H.; **David K. Murotake,** '75, back from army service in Europe and now engineering manager with RCA, Burlington, Mass.; **Michael W. Patrick,** '80, systems engineer with Texas Instruments, Inc., Houston, Tex.; **Lynn M. Roylance,** '72 (wife of **J. Payne Freret,** '68) project manager with Hewlett-Packard Co., Palo Alto, Calif.; and **Susan A. Thomas,** '76, owner and operator of Edge Co., Alexandria, Va.—John A. Tucker, Director, Course VI-A, Room 38-479, Cambridge, MA 02139.

VII
Biology

Two members of the faculty have been named to chairs made possible by the new affiliation with M.I.T. of the Whitehead Institute for Medical Research:

☐ **Herman N. Eisen,** Whitehead Institute Professor of Immunology.

☐ **H. Robert Horvitz,** '68, Whitehead Institute Career Development Associate Professor of Biology.

Dr. Eisen, an authority on the structure and function of antibodies, has been at M.I.T. since 1973; Dr. Horvitz joined the faculty in 1978 to pursue teaching and research on animal development and differentiation through studies of genetics, growth, and behavior.

Philip Sharp, professor of biology, is now associate director of the Center for Cancer Research, where he will be associated with Dr. Salvador E. Luria, director. The appointment recognized Professor Sharp's "growing leadership role in the center and in modern molecular biology in general," according to Professor Kenneth A. Smith, '58, vice-president for research.

X
Chemical Engineering

Michael Kell, S.M.'72, is currently in an M.D./Ph.D. program at Emory University, Atlanta, Ga., starting his first year of his Ph.D. in biophysics and has completed his first two years of medical school. . . . **Ernest Korchak,** Sc.D.'61, has been elected as president of Scientific Design Co., on January 1, 1981. . . . **Stephen D. Severson,** S.M.'76, writes, "I left Stearns-Roger Engineering Corp. after three years (1976-1979) as a chemical process engineer to begin my M.B.A. at the Wharton School of the University of Pennsylvania (1979-1981), and graduated with distinction. I took a job as a senior financial analyst with Exxon Co., U.S.A. at their Bayway Refinery, Linden, N.J., in the Business Analysis Section, where I can apply both technical and business knowledge. I married Martha Hennessy (Dartmouth 1976) on June 10, 1976, who now studies at Wharton for her M.B.A. and Ph.D. in education. Our daughter Kristina Jean Hennessey-Severson was born on May 5, 1980."

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XV

Management

Professor **Phillis A. Wallace** is the editor of *Women in the Workplace* (Boston: Auburn House, $21.95 [paper, $12.95]), in which nine experts, including Professor **Lotte Bailyn,** examine the economic, psychosocial, and legal aspects of women's employment and make suggestions for improving the opportunities for women workers.

In her own contribution to the book, Professor Wallace reviews the 16-year history of laws, regulations, and judical decisions that have benefitted women, notably the recent shift from litigation to negotiated settlements on women's rights issues. Professor Bailyn's essay is on the role of employers in improving the work experience of talented managerial women.

James W. Driscoll, assistant professor of industrial relations, will leave the Sloan School faculty this summer to devote full time to a national grass-roots campaign for a bilateral U.S.-Soviet nuclear weapons freeze. At issue, he says, is the "terrible danger we're all living under" with the proliferation of nuclear weapons, and "the futility of employing military might as a way of achieving democratic policy objectives."

Sloan Fellows

Kenneth L. Garrett, S.M.'75, formerly director of Operations Staff of the American Telephone and Telegraph Co., has been promoted to assistant vice-president. . . . **David H. Campbell,** S.M.'68, was named division vice-president of finance of the RCA Records Division, New York City. He was formerly director of international financial operations for the parent company. . . . **Albert O. Trostel,** S.M.'69, is currently assistant professor and department chairman of the Business Administration Department, College of St. Thomas, St. Paul, Minn. . . . **George E. Yeomans,** '41, reports that he fully enjoys retirement, golf, fishing, gardening, travel, and 1941 Sloan Reunions every other year. . . . **Roger W. Hale,** S.M.'79, is currently general manager, New York City region of AT&T Long Lines, responsible for engineering and plant operations.

XXII

Nuclear Engineering

J.L. DelValle Doblado, S.M.'78, has been promoted to director, chief operating officer of Andaluza de Piritas, SA, the largest new mining investment in Spain, which has just started operations. . . . **Jose G. Lepervanche-Valencia,** S.M.'80, is currently head of the Nuclear Engineering Department of the Venezuelan Institute for Scientific Research in Caracas.

Technology and Policy Program

Liz Mulcahy, '79, is the planning coordinator for the Office of Policy Development at CWRU Medical School and is living in Cleveland Heights, Ohio. Her husband, Marty Wahl, has his Ph.D. is biochemistry and is now in his second year of medical school. Liz and Marty are the proud parents of Daniel, born on November 20, 1981.

Lissa Martinez, '80, is presently doing freelance environmental engineering in Washington, D.C. She recently worked on a project where she did shop retrofitting for pollution abatement. . . . **Jennifer Knapp-Stumpp,** '81, is at Meta Systems, Inc., Cambridge, Mass., and is writing an economic impact analysis of proposed effluent guidelines on the organic chemical and pesticides industries. . . . **Donna DeVol,** '82, is working on energy management for Idaho National Engineering Labs, Idaho Falls. . . . **Nancy Gorelick,** '82, is presently working on a Ph.D. in Toxicology at M.I.T.—Professor Richard de Neufville, Chairman, Room 1-138, M.I.T., Cambridge, MA 02139.



D. K. McNear



T. H. Farquhar



R. W. Mann



L. Giles

McNear Heads Slate of New Alumni Officers

Denman K. McNear, '48, of San Francisco, president of the Southern Pacific Transportation Co., will be president of the Alumni Association for 1982-83.

Mr. McNear leads a slate of 11 officers and Corporation nominees chosen by the association's National Selection Committee early this year to fill vacancies which will occur on July 1.

Others chosen by the committee for positions on the Alumni Association's Board of Directors (two years) include Thomas H. Farquhar, '60, and Robert W. Mann, '50, vice presidents; and Lorna J. Giles, '75, Leslie K. Hruby, S.M.'73, Louis F. Kreek, Jr., '48, and Alfred Wu, '40, directors.

In addition, four alumni have been nominated for terms on the M.I.T. Corporation, effective July 1: David E. Kosowsky, Sc.D.'55 (five years), Angus N. MacDonald, '46 (five years), E. Kirkbride Miller, Jr., '41 (five years), and Frank Wyle, '41 (three years).

Mr. McNear joined Southern Pacific as a rodman-engineer in Sacramento upon graduating from M.I.T. in civil engineering, and he's been working on the railroad ever since—first in engineering assignments and later—beginning in 1967—in management. Meanwhile, he's completed a master's degree (1950) in the Stanford Graduate School of Business and attended the Advanced Management Program (1966) at Harvard Business School. Mr. McNear has been active in the M.I.T. Club of Northern California, as an educational counselor in the San Franciso area, and in national Alumni Association affairs as a member of the Board of Directors and Alumni Fund Board; he received the Bronze Beaver in 1967. Mr. McNear has been a member of the M.I.T. Corporation since 1979.

Mr. Farquhar is senior vice-president of Massachusetts Financial Services of Boston, an investment management firm. He graduated from M.I.T. in mathematics and returned two years later to earn a master's degree (1964) from the Sloan School of Management. Since then he's been active in fund raising, as president of his class, and in the M.I.T. Club of Boston and is now a member of the Alumni Fund Board (past chairman) and of the Alumni Association's Board of Directors.

Professor Mann has been at M.I.T. ever since entering as an undergraduate; he joined the faculty upon completing graduate study (S.M. 1951, Sc.D. 1957) in mechanical engineering and is now Whitaker Professor of Biomedical Engineering. During this period he has made important contributions in computer-aided design and—more recently—to engineering design applied to human rehabilitation. Many activities in the Alumni Association led to his receiving the Bronze Beaver in 1975.

Ms. Giles is currently associated with Hill Miller Friedlaender Hollander, Inc., architects of Cambridge, Mass. Her undergraduate degree was in art and design, and she also holds a master's degree in architecture (1977). She's been active in planning the M.I.T. Black Students' Conference on Science Technology and since 1979 has been secretary of the Black Alumni of M.I.T. (BAMIT).

As market manager at Digital Equipment Corp., Ms. Hruby is responsible for marketing industrial research systems to the electronics industry. Following graduate study at the Sloan School, Ms. Hruby continued in the school's administration for several years, and recently she has been chairman of the Program and Membership Committee of the Alumni Council.

Mr. Kreek is a patent attorny with ICI Americas, Inc., Wilmington, Del., where he's been active for many years in the M.I.T. Club of Delaware Valley and Alumni Fund activities. He's recently been named chairman of the Committee on Publication Awards of the Philadelphia Patent Law Association, and he was a member of the Alumni Fund Board from 1977-80.

A native of China, Mr. Wu came to the U.S. in 1936 to enter M.I.T. and continued to receive a master's degree in metallurgy in 1942. Since then he's been associated with Wah Chang Smelting and Refining Co. and Li Tungsten Corp. of New York, of which he is now vice-president.



L. K. Hruby



L. F. Kreek, Jr.



A. Wu

Three of the four nominees to posts on the M.I.T. Corporation are associated with successful companies of which they were founders: Dr. Kosowsky of Damon Corp., Boston, involved in medical, biotechnology, and animal health products and services; Mr. MacDonald of Angus MacDonald and Co., Inc., Greenwich, Conn., venture capital and corporate managers; and Mr. Wyle of Wyle Laboratories, El Segundo, Calif., providing a number of technologically related products and services. Mr. Miller, who attended Harvard Business School in 1949-50, has been chairman of the board of T. Rowe Price Associates, Inc., Baltimore, Md., since 1952.



Charles E. Holt III, 1936-1982: A Special Commitment to Teaching

Professor Charles E. Holt III, Ph.D.'62, Professor of Biology who was known by students and colleagues throughout the Institute as "Ned," died suddenly in Freiburg, West Germany, on February 12, at the age of 42. He was the victim of a heart attack while vacationing to visit scientific laboratories where he had worked during a sabbatical leave in 1978-79.

Throughout his career at M.I.T. beginning as a graduate student, Professor Holt had made a special commitment to undergraduate education. He was known as a superb teacher, and he was a champion of breadth in undergraduate curricula as well as of excellence in undergraduate teaching; he received the Baker Award for Undergraduate Education in 1965, when his innovative approaches led to the reorganization of the department's laboratory instruction program.

Meanwhile, Professor Holt was also recognized among his colleagues for original research on the genetic transitions in a plasmodial slime mold, *Physarum polycephalum*. It was an unconventional and promising approach to the genetics and physiology of development, and Professor Holt's colleagues—at first skeptical—have been enthusiastic in comments about its potential.

A native of Boston, Professor Holt's undergraduate degree was from Wesleyan University (1957). He joined the M.I.T. faculty a year after completing his doctorate and was named to the rank of full professor in 1979. Meanwhile, he served for four years as academic officer of the Biology Department and was for a time a member of the Undergraduate Activities Board, the Committee on Curricula, and other Institute advisory groups.

A memorial fund to benefit undergraduate education at M.I.T. has been established by the Department of Biology, and contributions may be sent to the Alumni Fund or to Professor Gene M. Brown, head of the department.

Edward J. Hanley, 1903-1982: "Statesman of the Business Community"

Edward J. Hanley, '24, retired chairman of Allegheny Ludlum Industries, Inc., who was a life member emeritus of the M.I.T. Corporation, died in Allison Park, near Pittsburgh, Pa., on March 13 after a long illness. He was 79.

Howard W. Johnson, chairman of the Corporation, described Mr. Hanley as "a distinguished leader of the steel industry and a statesman of the business community."

Mr. Hanley's association with M.I.T. began in 1920 when he entered as a freshman from Whitman, Mass. Ten years later, while he was with General Electric, Mr. Hanley became president of the M.I.T. Club of Eastern New York; by 1954 he was a member of the Board of Governors of the M.I.T. Club of Western Pennsylvania and in that year became a member of the Advisory Board to the new M.I.T. School of Industrial Management. Two years later he was chosen for Corporation membership—an assignment which he retained for 26 years before becoming life member emeritus in 1978. In 1959-60 Mr. Hanley served as 66th president of the Alumni Association, and in 1979 he received its Bronze Beaver Award.

Mr. Hanley participated in all the Institute's major fund drives during the period of his membership on the Corporation, and he and Mrs. Hanley were founding life members of the M.I.T. Sustaining Fellows.

Mr. Hanley joined Allegheny Ludlum Steel Corp. as secretary in 1936, becoming president and chief executive officer in 1951 and chairman of the board in 1962. During this period before his retirement in 1968 he was instrumental in a $130 million expansion program which built the company into a world-renowned manufacturer of specialty steel. He held the E. H. Gary Award (1959) of the American Iron and Steel Institute, the Metcalf Award (1965) of the Engineers Society of Western Pennsylvania, the Benjamin Fairless Award (1965) of the AIMME, and the Medal for Advancement of Research (1970) of the American Society for Metals.

Paul V. Keyser, 1907-1982

Paul V. Keyser, '29, former executive vice-president of Mobil Oil Corp. who was 77th president of the Alumni Association from 1970 to 1972 and a member of the M.I.T. Corporation from 1970 to 1977, died at the Memorial Sloan-Kettering Cancer Center in New York on February 7; he was 75.

Mr. Keyser held two major awards from the Institute—the Bronze Beaver of the Alumni Association (1972) and the Marshall B. Dalton Award from the Corporation Development Committee (1979). He had served on the CDC since 1965; was a member of the Corporation Joint Advisory Committee from 1970-72 and the Corporation's committee that selected Professor Jerome B. Wiesner to be president in 1970. Since 1974 he had played an important role in the Leadership Campaign as a member of its Steering Committee. In short, he had been an advisor in one or more capacities to the last four presidents of the Institute.

Mr. Keyser was equally recognized, and even more widely known, for his service in every aspect of alumni affairs. He was elected to two consecutive terms as president of the Alumni Association and had held many other association posts, including membership on the Board of Directors; the Finance Committee from 1972 to 1975, the last year as chairman; and the Personnel Committee, of which he served as chairman in 1976.

Mr. Keyser had long been active in the Alumni Center of New York and was its chairman from 1969 to 1970. His varied services to the Alumni Fund included Special Gifts Chairman in 1966, the first New York Alumni Fund Council Chairman from 1968 to 1971, and membership on the Alumni Fund Board, and on the National Sponsoring Committee for the Building 10 renovation drive.

Raymond S. Stevens, 1895-1982 "Resourceful, Helpful, and Loyal"

Raymond S. Stevens, '17, former president of Arthur D. Little, Inc., who had been prominent in Alumni Association affairs for over 50 years, died February 15; he was 87. Dr. James R. Killian, Jr., '26, former chairman of the Corporation, described Mr. Stevens as "resourceful, helpful, and loyal" in all his many relationships with the Institute.

Mr. Stevens was in the first class to graduate in M.I.T.'s course in business and engineering administration, and he joined Arthur D. Little, Inc., immediately after military service in World War I. Mr. Stevens was elected secretary of his class in 1922, a post he held until 1957. By 1925 he was a member of the M.I.T. Alumni Council and in 1930 became a member of its Executive Committee. Eight years later he was elected vice-president of the Alumni Association and he served as its 51st president from 1944-45. Thereafter he was active on countless Alumni Association committees and continued as a leader of the Class of 1917, which Dr. Killian describes as "one of the most famous of the Institute." He received the Bronze Beaver in 1970.

Following completion of his term as

president of the Alumni Association, Mr. Stevens was elected to a six-year term on the M.I.T. Corporation, and later he served on a number of its visiting committees.

Mr. Stevens participated in all major capital drives of the Institute—Mid-Century Fund, Faculty Salary Fund, Second Century Fund, and M.I.T. Leadership Campaign—and was active in Alumni Fund solicitation until his death.

Madeline R. McCormick, 1896-1982

Madeline R. McCormick, who joined the staff of the Alumni Association in 1920 and rose to become the association's assistant treasurer for 13 years before her retirement in 1963, died at a nursing home in Weymouth, Mass., on February 15. She was 86.

Ms. McCormick graduated from high school in Portland, Maine, and made her home in Quincy, Mass. In recognition of her service to the association, she was made an honorary member in 1958.

George Bottomley, 1912-1982

Dr. George Bottomley, who had been a physician in the M.I.T. Medical Department for four years following his retirement from Sancta Maria Hospital, Cambridge, died in North Hampton, N.H., of a severe heart attack on February 7; he was 70.

Dr. Bottomley studied at Harvard and Tufts Medical School, interning at Boston City Hospital; while serving at Sancta Maria Hospital, he had also taught at Boston University.

Charles H. Blake, 1903-1981

Charles H. Blake, '24, who was a member of the Biology Department faculty for more than 30 years after receiving his bachelor's degree in that field, died suddenly as the result of a severe heart attack in Hillsborough, N.C., on December 6, 1981. He was 78.

Professor Blake received his Ph.D. from the department in 1928 and continued teaching and research in the field of natural history until retirement in 1956.

Thomas P. Pitre, 1899-1982

Thomas P. Pitre, who as associate dean of students had responsibilities for financial aid and scholarship policies from 1930 to 1963, died suddenly on February 27 at his retirement home in Dunedin, Fla.; he was 83.

Dean Pitre first came to M.I.T. as a member of the Department of Chemistry in 1920 after completing studies in that field at Amherst College. He soon entered the dean's office with the task of organizing a freshman scholarship program, and this led to his long-time career in financial aid. During the 33 years of his administration, scholarship and loan programs grew from an annual level of $5,000 to $1.9 million.

In recognition of his contributions through scholarships and loan programs, Dean Pitre was made an honorary member of the Alumni Association in 1948; upon retiring in 1963 he became for two years director of clubs for the association.

Deceased

Henry S. Mears, '06; July 20, 1980; 824 SW Vista Ave., Portland, Ore.
George D. Camp, '16; November 6, 1981; Apartado 1005, Mexico 1 DF, Mexico.
Rene A. Pouchain, '17; December 10, 1981; Orange Home Inc., Hatboro, Penn.
Raymond S. Stevens, '17; February 15, 1982; Meadow Woods Rd., RFD #86, Essex, Conn.
Richard Bower, '20; January 1, 1982; 66 Front St., Weymouth, Mass.
Ray D. Cooper, '21; December 28, 1981; 212 Medford Leas, Medford, N.J.
Richard W. Smith, '21; January 6, 1982; 6162 Commadore Ct., Columbia, Md.
Daniel A. Brown, Jr., '22; January 7, 1982; PO Box 193, Pocasset, Mass.
Lloyd A. Elmer, '22; September 6, 1981; 130 Pine Grove Ave., Summit, N.J.
Fay H. Osborne, '22; February 13, 1982; PO Box 174, Sunapee, N.H.
Columbus E. Lord, '23; January 15, 1982; Manor Care Nursing Center, 550 S Carlin Springs Rd., Arlington, Va.
John W. Ogg, '23; January 19, 1982; 2501 E 104th St., Denver, Col.
Charles H. Blake, '24; December 6, 1981; PO Box 10, Hillsborough, N.C.
John W. Cannon, '24; December 31, 1981; 128 E 7th St., Apt. 101, Plainfield, N.J.
Peter H. Kirwin, '28; January 18, 1982; Sound View Dr., Hampstead, N.C.
Francis Gerard Lake, '28; May 29, 1981; c/o H.M. Kidder, Jr., PO Box 728, Huntington, N.Y.
John C. Leslie, '28; January 19, 1982; Mill Reef Club, St. Johns, Antigua West Indies.
Allan H. Meinecke, '30; December 4, 1981; 2071 Valderas Dr., Apt. E, Glendale, Calif.
John G. Cree, '32; November 14, 1981; 2025 Scotland Ave., Unit D, Chambersburg, Penn.
Richard R. Hall, '32; November 22, 1981; Rowell Hill Rd., New London, N.H.
Arthur F. Ordas, '36; January 16, 1982; 18910 N Coldwater Rd., Huntertown, Ind.
Halsey A. Weaver, '36; September 6, 1981; 181 Anchorage St., Fort Myers Beach, Fla.
Roger A. McNamara, '38; January 9, 1982; 125 Depot, PO Box E-92, South Easton, Mass.
James E. Haff, '45; October 15, 1981; c/o H.L. Campbell, 487 Brighfield Trail, Manchester, Mo.
James D. Buttolph, '46; January 5, 1982; 59 Pine Cliff Rd., Chappaqua, N.Y.
David R. Campbell, '47; January 16, 1982; 207 Marked Tree Rd., Needham, Mass.
Charles H. Dolan III, '48; December 31, 1981; 9 St. James Pl. #919, Nashua, N.H.
William A. Farmer, '50; January 5, 1982; 2273 Country Club Dr., Pittsburgh, Penn.
James M. Sangster, '51; July 2, 1981; Cedar Ln., Mendon, Mass.
Harold M. Sharaf, '52; February 1982; 205 Erin Rd., Stoughton, Mass.
Oliver H. Gilbert, Jr., '53; 1981; 1441 Summit Rd., Berkeley, Calif.
James F.B. Rude, '54; December 29, 1981; 345 East County Line Rd., Rosewood Ct. Apts. #b-5, Hatboro, Penn.
Charles E. Holt III, '62; February 15, 1982; 1465 Sudbury Rd., Concord, Mass.
Andrew J. Tobish, '77; March 6, 1981; 1751 East 14th St., Brooklyn, N.Y.

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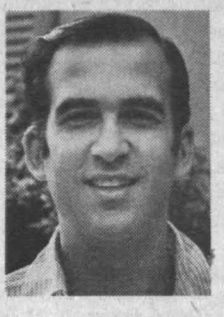
Patent, Trademark, and other Intellectual Property Matters

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Puzzle Corner
Allan J. Gottlieb

Painless Number Theory

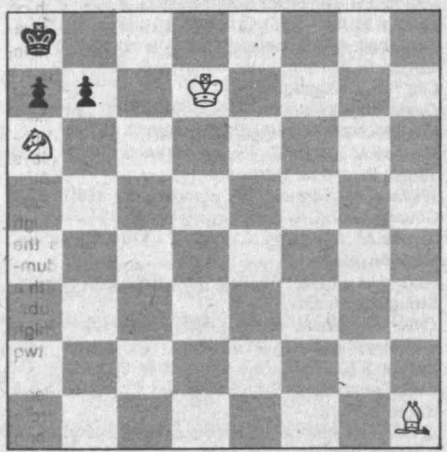


Allan J. Gottlieb, '67, is associate research professor of mathematical sciences at the Courant Institute of Mathematical Sciences, New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer St., New York, N.Y., 10012.

Let me begin with some really good news. At 6:08 p.m. on Sunday, March 14, my wife Alice gave birth to our first child, a nine-pound one-ounce boy. Mother and son are doing fine—father's status is unknown. Since we had participated in a Lamaze training course, I was able to assist during labor and delivery—a truly memorable and fulfilling experience. Although the husband's role in childbirth is relatively minor, Alice says I was very helpful and I believe that I performed my (comparatively easy) functions quite well. Alice of course was the real star and was magnificent. Forgive the new and proud father for rambling on but let me dedicate this column to the fruit of Alice's labor, David Bendix Gottlieb.

Problems

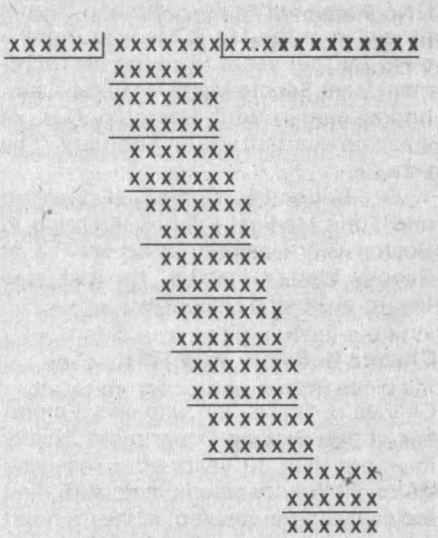
M/J 1 Jerome Taylor sent us the following "double" problem which he attributes to William Crapo:
Given the positions shown, White is to play and mate in three moves. In the first problem, the black pawns move *up* the board, in the second the black pawns move *down* the board.



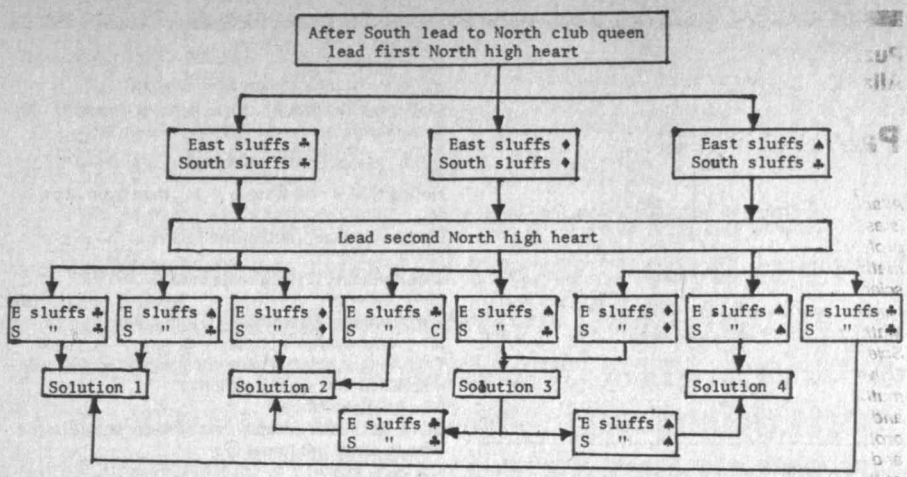
M/J 2 Roy Sinclair wants to know how many regular decompositions there are of the sphere. A regular decomposition is one in which the surface is subdivided into congruent spherical regular polygons, where a spherical polygon is called regular if all its vertex angles are equal.

M/J 3 Alan LaVergne has a number theory problem—but don't despair, it's not that bad: Given an integer $n>0$ and an odd integer m, prove that any odd integer has one and only one mth root mod 2^n.

M/J 4 The following problem was published in *Technology Review* in 1939 in an advertisement of Calibron Products, Inc., credited to an earlier publication (1922) in the *American Mathematical Monthly* credited to a Professor Shuh of Delft. The problem is to determine the 145 digits in this skeleton division in which each "x" represents one digit. The nine quotient digits shown in bold type form a repeating decimal (i.e., the group as a whole repeats indefinitely). Divisor and dividend have no common factor. Find the digits; there is only one possible answer.



M/J 5 Howard Nicholson has a problem that is really a piece of cake—in fact, several pieces:
Consider the problem of dividing a cake equally between two people A and B using only a knife. Assuming A and B always try to maximize their shares, the well-known solution is to let A cut the cake into two pieces and B choose one piece. This forces A to cut the cake into pieces as equal in size as possible since otherwise B would choose the bigger piece. What is sought is a procedure for the generalized problem, under similar circumstances, to divide a cake equally among three or more people subject to the following conditions:
1. The procedure must allow *each*

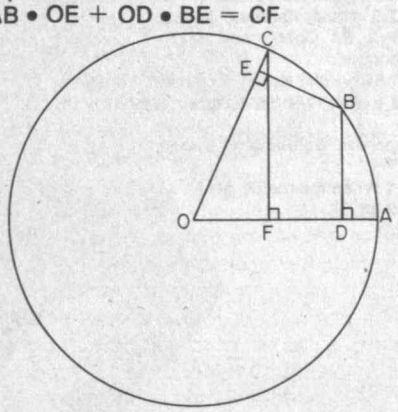


person to have the opportunity of receiving his fair share of the cake regardless of the actions of any other person or group of persons who may have previously schemed to obtain more than their fair share of cake and then to divide it up later.
2. The procedure must involve only a finite number of cuts and steps.
3. Except for temporal ordering, no statement can be conditional or depend on the outcome of any previous statement.
4. No statement can specify in any way the size of a piece or pieces to be cut or chosen.
5. The complete procedure is assumed to be known by all before being carried out.
6. The only allowed operations in the procedure are cuts and choices and combining more than one piece into a single piece. Possible steps, for example, could be (1) A cuts the cake into 6 pieces. (2) B chooses 4 pieces and puts them together and cuts the sum into three pieces. (3) C chooses one piece from A and one from C, etc.

Speed Department

M/J SD 1 We are given points A, B, and C arbitrarily located on the quadrant of a circle with BD, BE, and CF perpendicular to OA, OC, and OA, respectively. Under what conditions do the line segments satisfy the following equation?

$$AB \bullet OE + OD \bullet BE = CF$$



M/J SD 2 Greg Huber wonders what is the maximum amount of change in the form of pennies, nickels, dimes, quarters, and half-dollars you can have and still be unable to change a $1 bill.

Solutions

JAN 1 South, on lead, is to make all seven tricks against any defense, with hearts as trumps:

	♠ — ♥ K Q ♦ 5 ♣ Q 10 9 5	
♠ 8 7 6 5 ♥ J 5 ♦ — ♣ J		♠ K 10 ♥ — ♦ 10 ♣ 8 7 6 4
	♠ J 9 3 ♥ — ♦ J ♣ A K 3	

The following graphic solution, including the chart at the top of this column, is from John Boynton:

1. First lead by South has to be a small club to the queen in dummy, since any other lead, except a high club, results in either a trump trick by West or a spade trick by East, unless dummy ruffs, in which case West will ultimately get a trump trick. If South leads a high club first, there is no way to get to dummy without either trumping a spade, which as before yields a spade trick to West, or leading the small club, which is naturally trumped by West.
2. Second lead from dummy has to be a high heart, since a diamond lead is ruffed by West, as is any club lead. Here, declarer must watch East's sloughs carefully. If East makes the mistake of sloughing a club on this first heart lead from dummy, South merely sloughs both high clubs to establish dummy's good clubs, followed by a lead to South's good diamond. If East sloughs a diamond on dummy's first heart lead, South follows with a slough of the ♦J. If East sloughs either spade on the first heart lead from dummy, South still sloughs a high club.
3. If, after a diamond slough by both East and South on the first heart lead from dummy, East sloughs a club on the second heart lead from dummy, South also sloughs a high club and next plays the good ♦5, sloughing South's remaining high club and running dummy's good clubs. If East chooses to slough a spade on the second high heart lead from dummy, South also sloughs the high club and leads the good diamond from dummy. If East now sloughs a club, South follows with a high club slough, establishing dummy's good clubs. If East sloughs the ♠K, declarer is left with a high club in the South hand for an entry to the top two remaining spades.
4. If East sloughs a spade on the first heart lead from dummy, declarer still sloughs a high club from South and watches East's slough on the second heart lead from dummy. If East sloughs a club, the second high club is sloughed from South and dummy's good clubs are taken before leading to the

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good diamond in South. If East sloughs spade-diamond on the first two heart leads, declarer leads the good ♦5, after also sloughing South's diamond when East sloughs a diamond, and watches East's critical third slough. If a club is sloughed, South's remaining high club is sloughed, establishing dummy's clubs. If the last spade is sloughed by East, declarer again has an entry to South in the remaining high club to cash the good spades. See where the following four solutions are shown:

Solution 1: Play dummy's good clubs from top, sluffing South's spades; lead to South's good diamond.

Solution 2: Board is good, with high clubs led from top after sloughing South's remaining club on ♦5.

Solution 3: Play dummy's good diamond, watch East's slough: if a club, slough South's remaining high club and proceed with Solution 2; if a spade, slough South's low spade and proceed with Solution 4.

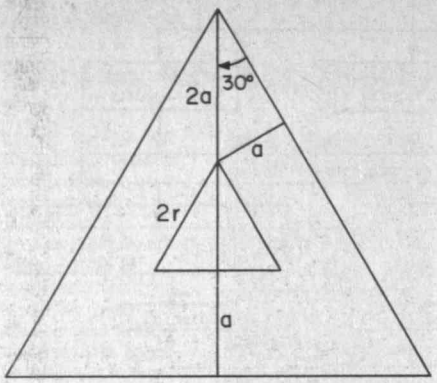
Solution 4: Lead to good South hand via South's high club and play good spades.

Also solved by Charles King, Richard Hess, Matthew Fountain, Edwin McMillan, Charles Rivers, William Katz, Winslow Hartford, Edgar Rose, Carl Peterson, John Rutherford, John Woolston, Howard Katz, Doug Van Patter, Mike Bercher, Manuel Madnick, Avi Ornstein, Matt Bendaniel, Steve Feldman, and the proposer, Emmet Duffy.

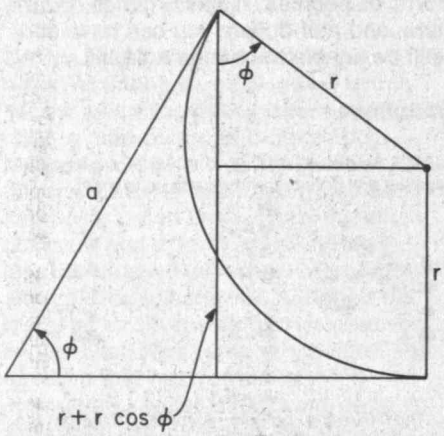
JAN 2 What is the minimum possible volume of a regular tetrahedral box to contain four identical balls?

Selecting a solution for this problem was difficult, since there were several fine responses each with carefully drawn figures. Eventually the dart landed on Charles Rivers' solution:

1. For a regular tetrahedron with sides of length L,
Volume $= L^3/6\sqrt{2}$.
Altitude of a side $= \sqrt{3}L/2$.
Altitude of tetrahedron $= \sqrt{2}L/\sqrt{3}$.
Angle of intersection of two adjacent sides (ϕ):
$\cos\phi = 1/3$; $\sin\phi = 2\sqrt{2}/3$.
2. Each side is tangential to three spheres of radius r. The points of tangency form an equilateral triangle of side 2r, which is equidistant from the edges of the side by distance a.



Altitude of side $= \sqrt{3}L/2 = \sqrt{3}r + 3a$, or
$L = 2r + 2\sqrt{3}a$.
3. Consider a slice parallel to the altitude and through a point of tangency:



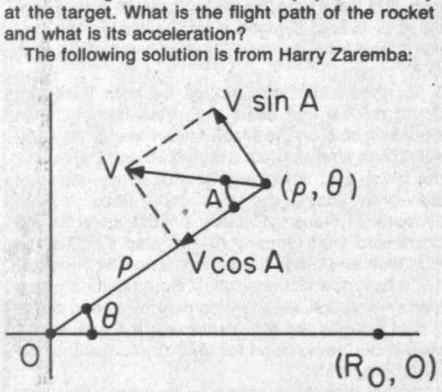
$a = [r(1 + \cos\phi)]/\sin\phi = \sqrt{2}r$.
4. Therefore, $L = 2r + 2\sqrt{6}r = 6.9r$, and
Volume $= (6.9r)^3/6\sqrt{2} = 38.7\ r^3$.

Also solved by John Woolston, Harry Zaremba, Norman Wickstrand, Avi Ornstein, Emmet Duffy, Lyndon Welch, Richard Hess, Irving Hopkins, Matthew Fountain, and the proposor, Rob Cave.

JAN 3 *Technology Review* apologizes for the absence of a solution to JAN 3 in this issue. Due to circumstances beyond the author's control, that solution is being held for publication in "Puzzle Corner" for July, 1982.—*Ed.*

JAN 4 A rocket is launched with constant speed from the point (R_0,O) toward a stationary target located at (O,O). The rocket has a seeker that is offset from the velocity vector of the rocket by a constant angle A. The seeker always points directly at the target. What is the flight path of the rocket and what is its acceleration?

The following solution is from Harry Zaremba:



In the figure shown, v is the rocket velocity and (ρ, Θ) are the polar coordinates defining the position at any instant of time t.
The radial velocity toward the target will be
$d\rho/dt = \dot{\rho} = -v\cos A$ (1)
and the velocity perpendicular to ρ will be
$\rho\,(d\Theta/dt) = \rho\dot{\Theta} = v\sin A$ (2)
Dividing (1) by (2),
$d\rho/\rho d\Theta = -(\cos A)/(\sin A) = -1/(\tan A)$, or
$(d\rho)/\rho = -d\Theta/(\tan A)$. (3)
Integrating (3),
$\log\rho = -\Theta/(\tan A) + \log k$, or
$\rho/k = e^{-\Theta/(\tan A)}$ (4)
Noting that $\Theta = 0$ when $\rho = R_0$, then from (4), $k = R_0$.
Hence, the flight path of the rocket is
$\rho = R_0 e^{-\Theta/(\tan A)}$.
Differentiating (2) with respect to t,
$\rho\ddot{\Theta} + \dot{\Theta}\dot{\rho} = 0$. (5)
Substituting $\dot{\rho}$ and $\dot{\Theta}$ from (1) and (2) into (5),
$\rho\ddot{\Theta} + (v/\rho\cdot\sin A(-v\cos A) = 0$.
Thus, the angular acceleration of the rocket with respect to the target position is
$\ddot{\Theta} = (v/\rho)^2\sin A\cos A$.
Since the radial velocity is constant, the rocket's time to reach the target is
$t = R_0/(v\cos A)$.

Also solved by Matthew Fountain, Richard Hess, Emmet Duffy, Randall Gressang, John Woolston, Michael Jung, and the proposer, Tom Hafer.

Better Late Than Never

JAN SD 1 Richard Desper disagrees with the published solution; Elliot Roberts suggests a windmill-driven propeller; and Richard Russell writes: The published solution seemingly violates the basic laws of vector analysis. Consider a sail as a flat plane, set, for example, 30° offwind. This locally changes the direction of the wind and sets up a resultant force on the plane that is at right angles to that plane or 120° offwind. However, if the plane is free to move 45° relative to the wind source, then the 120° resultant force can be represented by two force components or vectors, one at 45° to the wind and one at 135° to the wind. Graphically we can see that the 45° vector drives the boat forward in the direction of the 45° vector and that the 135° vector neither helps nor hinders such movement. Now without changing the angle of the attack of the plane (30°), we can move the plane on a course that is closer to the wind. Inspection shows that the forward-drive component becomes less, reaching zero by the time the movement coincides with the plane at 30°. If the movement is brought still closer to the wind, then the resultant component is negative or drives the system back away from the wind as would be expected. Generalizing: 1. The sail plane has to be angled to the wind. 2. The movement of that sail plane has to be at a greater angle than the sail plane itself. 3. Given conditions 1. and 2., the boat will move forward. 4. As both conditions 1. and 2. approach 0, condition 3. remains valid if friction is 0.

JAN SD 2 Al Weiss, Everett Leroy, and Chester Tudbury found other solutions.

A/S1 Fred Trescott notes that the position cannot occur in a game.

A/S4 Irving Hopkins notes that no one thought of the circumscribing circle.

OCT 3 L. Steffens found a simpler solution and Ahmet Karakas has responded.

OCT 4 Greg Huber believes that the published solution neglects a term involving the central tetrahedron's edges. He obtains V = 0.5402619.

OCT 5 Ahmet Karakas has responded.

N/D 2 Ed Chang and Mary Lindenberg have responded.

N/D SD 1 John Kellam found 100 triangles.

FEB 4 John Rule disavows authorship.

Proposers' Solutions to Speed Problems

SD 1 When the radius is 1.

SD 2 $1.19.

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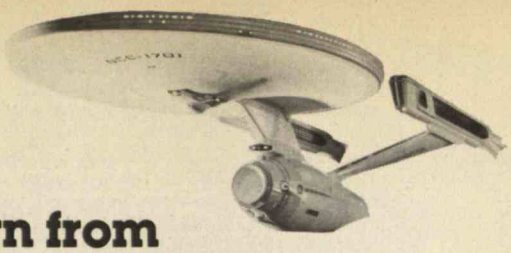
Anthony D. Kurtz, 1951

Ronald A. Kurtz, 1954

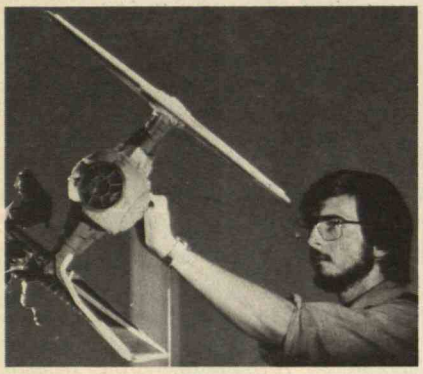
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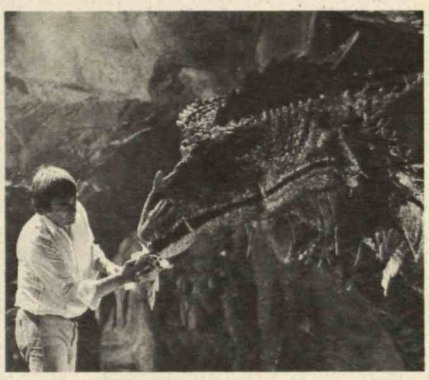
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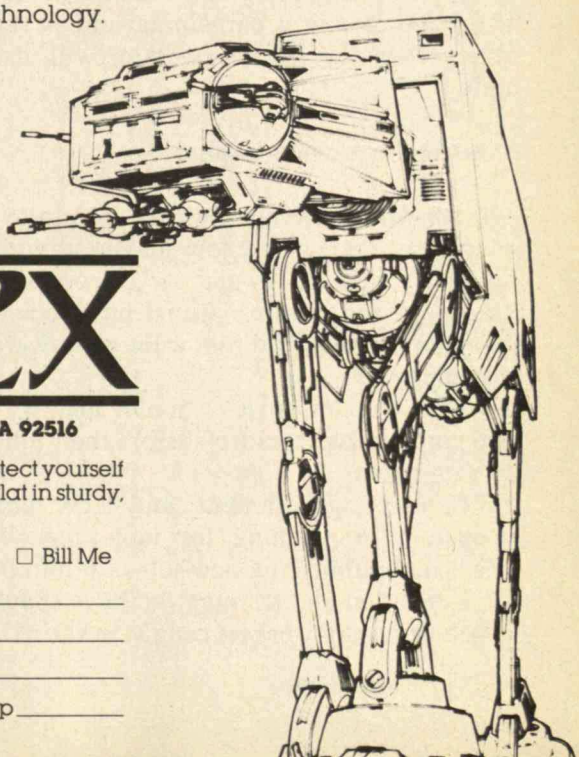






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	Robot capabilities commercially available	Robot capabilities sought for the future
Learning	Online programming via teach/playback modes; teaching in multiple coordinates; local and library memories of any size.	General purpose robot programming languages; off-line programming; "learning" with experience
Decision-making	Program selection by random stimuli; computer interpretation of sensory data; computer interfacing.	"World model" of working environment.
Sensing	2-D vision with binary recognition; force/torque sensing; limited speech input.	Positional sensing; 3-D vision with grey levels and color; tactile sensing; voice communication; improved processing of sensory inputs; coordination of multiple sensory inputs and control
Manipulation	Six infinitely controllable articulations between base and gripper; point-to-point control; position accuracy repeatable to 0.3 mm; handles up to 150 kilos.	Miniature manipulators; greater position accuracy; greater dynamic control; general-purpose hands; multiple hand-to-hand coordination.
Mobility	Synchronization with moving workpieces.	Programmable omnidirectional mobile bases; self-navigating mobile bases; "walking" robots.
Reliability	400 hours mean time between failures.	Self-diagnostic fault tracing.

The capabilities of today's industrial robots and a wish-list of capabilities to be developed, based on responses to a CMU Robotics Survey in April 1981.

The integrity of the bargaining unit is another important bargaining issue. For example, the UAW has made several agreements stating that all jobs previously in a bargaining unit will stay in the unit. Thus, if an operator in a bargaining unit is replaced by a robot, then the robot's operator will also be in the unit.

Investing in Human Capital

On the whole, private industry is doing very little to prepare workers whose jobs may be eliminated or substantially changed by the use of robots. To ease the transition and ensure optimal productivity from our "human capital," the following goals warrant serious consideration:

☐ Affected industries should identify vulnerable categories of workers well before their jobs are actually eliminated.

☐ Industry, government, and labor unions should cooperate in planning for long-range employment needs and publicizing new job-skill requirements.

☐ Education and training facilities should be established to retrain workers caught in shrinking skill categories in more marketable skills. Otherwise, unemployment is likely to become pervasive, especially among the least-skilled workers.

☐ Industry and government separately or jointly should create facilities to locate suitable jobs for displaced workers and to help pay the costs of relocation.

☐ Unemployment compensation should be legislatively restructured into a job-security fund financed jointly by workers and employers (similar to Social Security). The fund would be used to pay for transportation, maintenance, and retraining of displaced workers on a sliding scale, with benefits proportional to seniority.

The transition to the factory of the future is occurring now. Manufacturers, government, and labor unions can ill afford to ignore the challenge of cooperatively upgrading the skills of the nation's workers when an unprecedented need for people with new skills is imminent. If appropriate measures are not taken, the nation will experience unnecessary economic distress and lost opportunities.

Further Reading

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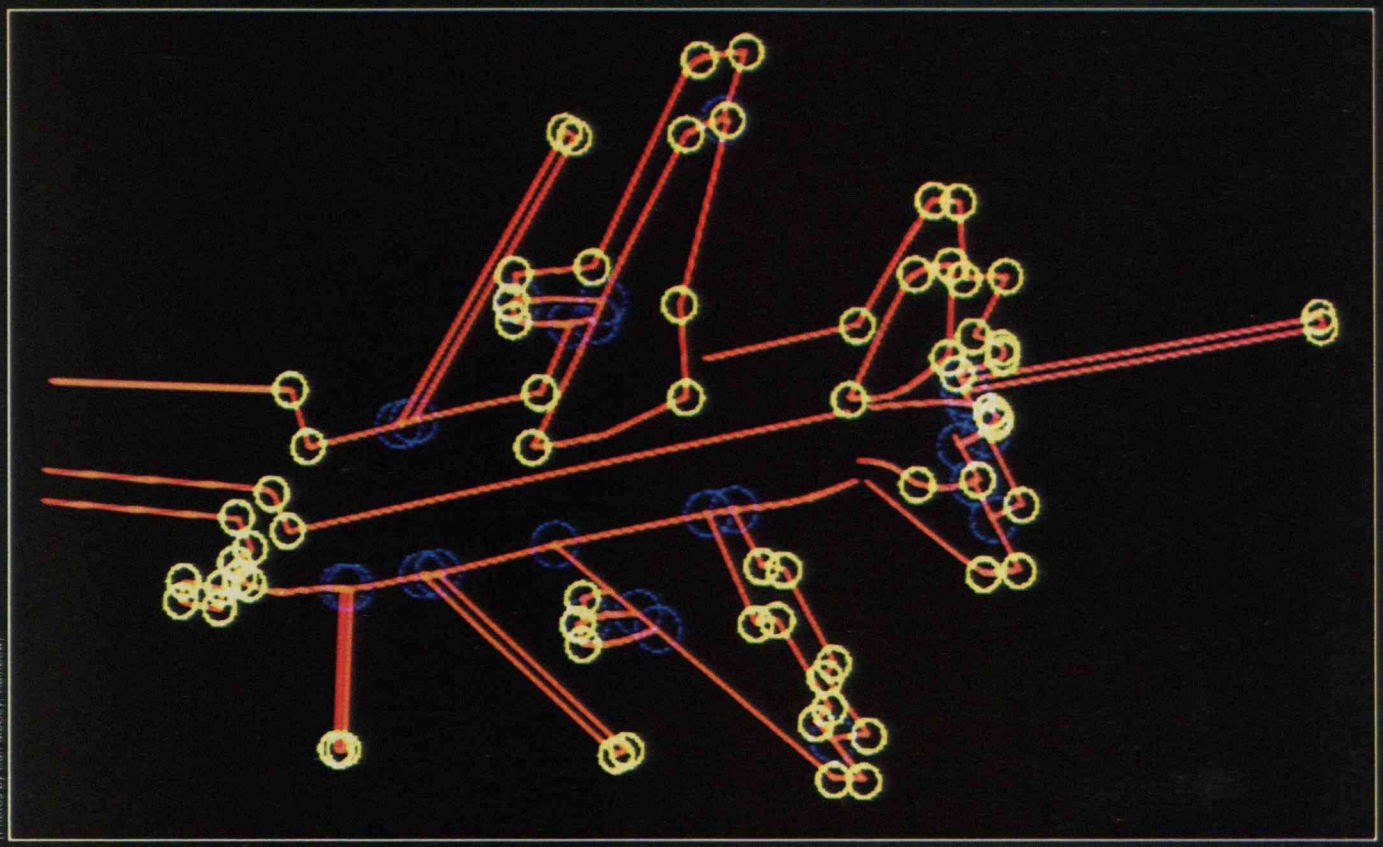
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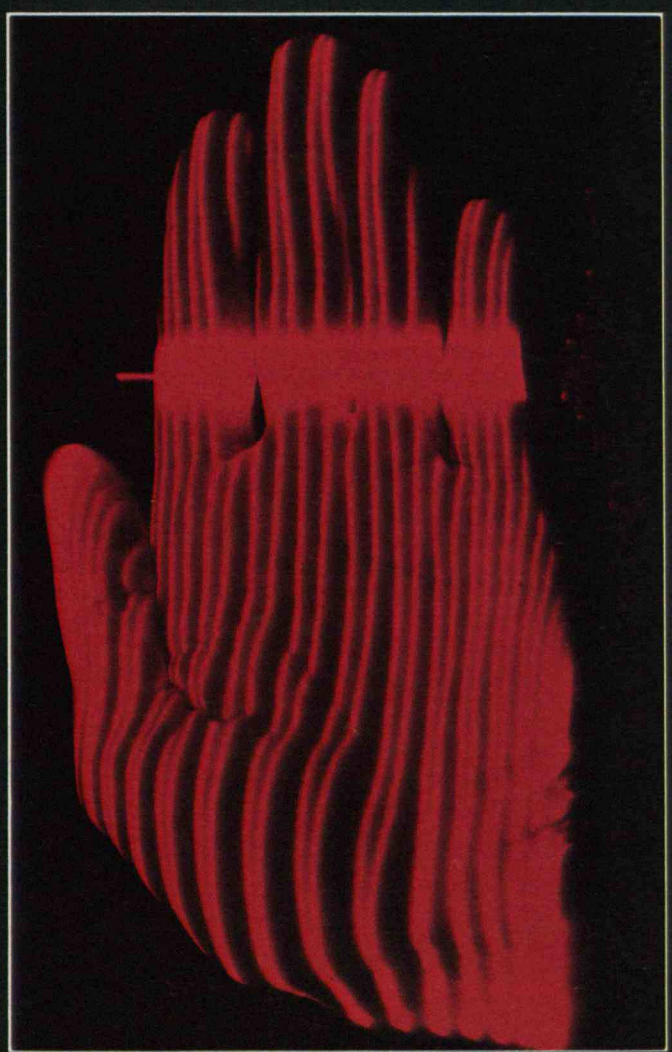
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Robert Ayres is professor of engineering and public policy at Carnegie-Mellon University. **Steve Miller** is currently completing a doctorate and is a lecturer in the Department of Engineering and Public Policy at Carnegie-Mellon. He and Dr. Ayres are coauthors of *Robotics: Applications and Social Impacts* (Ballinger Press, forthcoming).



(Photos by Dan McCoy, Rainbow)

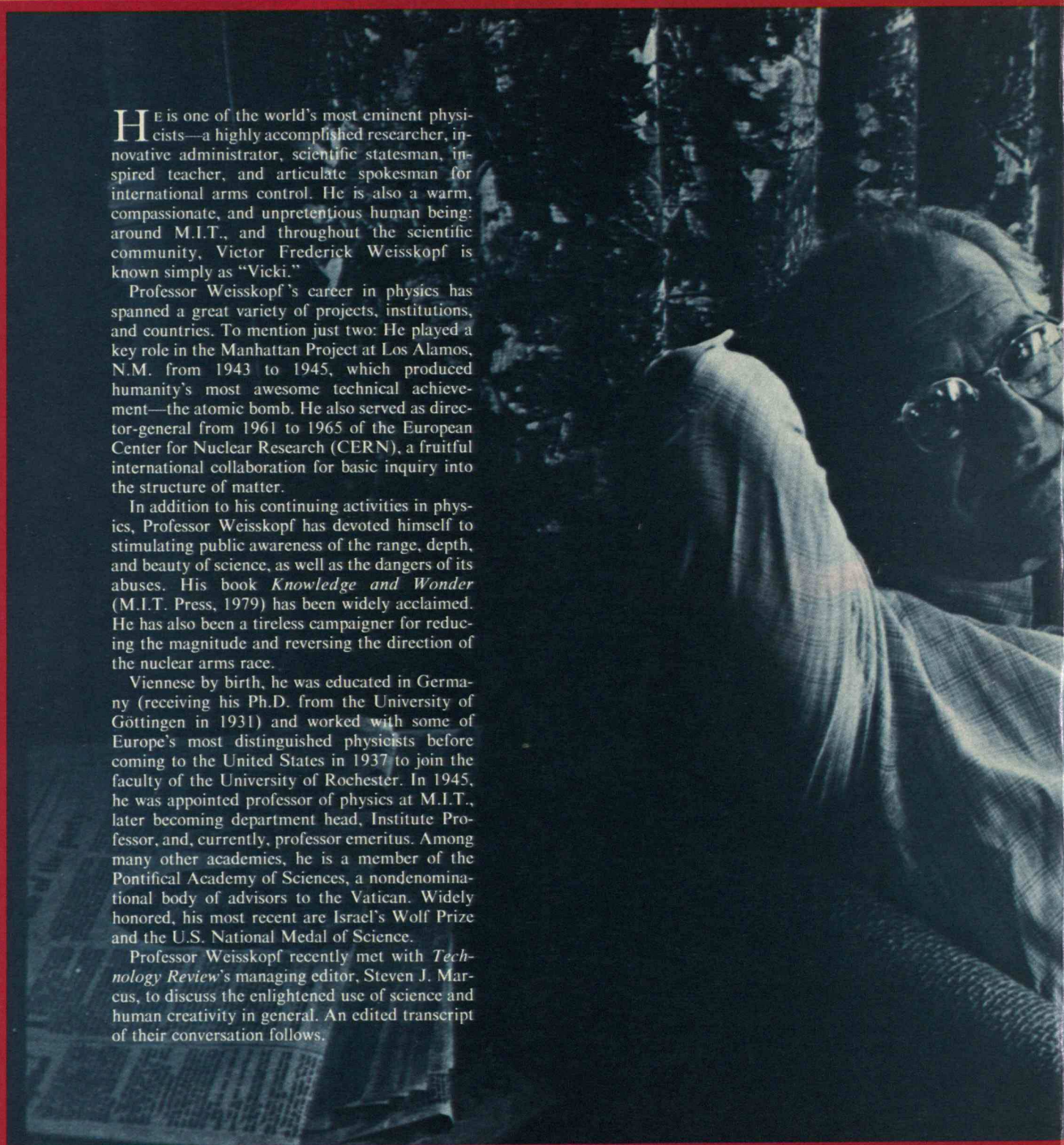




To recognize the airplane above, a robot's camera eye transmits a picture to a computer, which simplifies the image into its most critical points (top).

Robots at Carnegie-Mellon University are taught to recognize objects, such as the hand at right, that are lighted by a laser scan.

On Knowledge, Wonder, and World Peace:



He is one of the world's most eminent physicists—a highly accomplished researcher, innovative administrator, scientific statesman, inspired teacher, and articulate spokesman for international arms control. He is also a warm, compassionate, and unpretentious human being: around M.I.T., and throughout the scientific community, Victor Frederick Weisskopf is known simply as "Vicki."

Professor Weisskopf's career in physics has spanned a great variety of projects, institutions, and countries. To mention just two: He played a key role in the Manhattan Project at Los Alamos, N.M. from 1943 to 1945, which produced humanity's most awesome technical achievement—the atomic bomb. He also served as director-general from 1961 to 1965 of the European Center for Nuclear Research (CERN), a fruitful international collaboration for basic inquiry into the structure of matter.

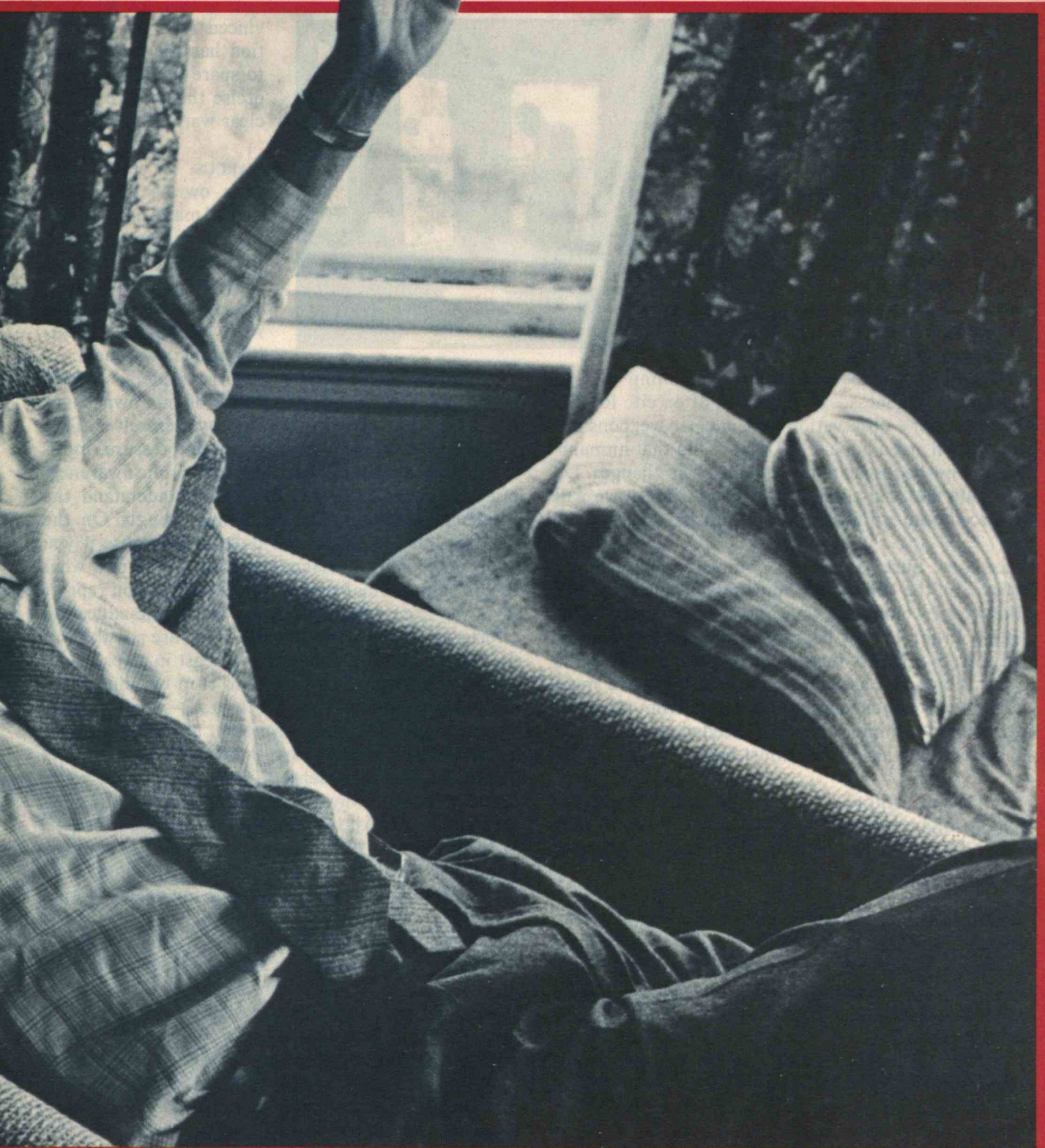
In addition to his continuing activities in physics, Professor Weisskopf has devoted himself to stimulating public awareness of the range, depth, and beauty of science, as well as the dangers of its abuses. His book *Knowledge and Wonder* (M.I.T. Press, 1979) has been widely acclaimed. He has also been a tireless campaigner for reducing the magnitude and reversing the direction of the nuclear arms race.

Viennese by birth, he was educated in Germany (receiving his Ph.D. from the University of Göttingen in 1931) and worked with some of Europe's most distinguished physicists before coming to the United States in 1937 to join the faculty of the University of Rochester. In 1945, he was appointed professor of physics at M.I.T., later becoming department head, Institute Professor, and, currently, professor emeritus. Among many other academies, he is a member of the Pontifical Academy of Sciences, a nondenominational body of advisors to the Vatican. Widely honored, his most recent are Israel's Wolf Prize and the U.S. National Medal of Science.

Professor Weisskopf recently met with *Technology Review*'s managing editor, Steven J. Marcus, to discuss the enlightened use of science and human creativity in general. An edited transcript of their conversation follows.

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An Interview with Victor Weisskopf





MARCUS: The issue that dominates your popular writing—what you clearly consider to be "the number-one problem"—is the nuclear arms race. You've stated that "with the discovery of fission, mankind entrained cosmic forces with human irrationality," and you've labeled the situation "a mighty tinderbox," "a manmade volcano," "a Sword of Damocles," ultimately calling it "the triumph of craziness." And yet you often cite Robert Oppenheimer's observation that nuclear weapons are both a peril and a hope—the hope being that humanity may now be forced to make some basic changes. Do you truly feel that there is a good possibility we will be forced onto a different, more humane track?

WEISSKOPF: Sure. I am an optimistic character. I believe in the ability of humankind to save itself; otherwise I would stop working on arms control altogether. From its very beginning, the human race has had to rely upon its intelligence to survive. There is always hope, and as long as there is hope, we must persist. You can choose another quote from my writings: that "a miracle may be needed to avoid the holocaust, but this miracle must happen."

MARCUS: But "miracle" is a religious term. It's one thing for the president to say "let us pray" and leave it at that, but for a scientist to invoke the supernatural is a little surprising.

WEISSKOPF: What I mean is that we need not only the powers of intelligence but also the powers of morality, conviction, ethics, and all the things that religion has stood for. We cannot end the arms race by purely rational—scientific—means. We can solve it only by moral means.

In this connection, let me paraphrase the Pope's recent letter to President Reagan. He says that he is very worried about public opinion, that people are becoming accustomed to the idea that the use of such murderous weaponry, previously quite unthinkable, is now possible, if not probable. The greatest danger, he says, is to believe it will happen. He is deeply convinced that our generation has the moral duty to spare no effort to exorcise the spectre of nuclear war.

MARCUS: It seems that your own activity, and that of many other scientists over recent years, has been to influence leaders—to help "exorcise the spectre"—indirectly through stimulating public awareness.

WEISSKOPF: I don't believe that the leaders we have now—and I'm not speaking only of our own country—will really take up new ways by themselves. That will come about only through public pressure, motivated by public awareness. And this public awareness must be twofold. People must first understand the tremendous danger, but that's not enough. On the contrary, that is almost self-defeating because if you know only about the danger and you don't know what to do about it, you become inured to it, or you repress it, as the Pope suggested. So in our public-education efforts we also have to show that there are possibilities for getting *rid* of the danger—at least in steps.

The first step, of course, is to stop building more weapons, a moratorium—a "freeze"—which I favor very strongly. The usual argument against the freeze is that we are not equal, that the Russians are running ahead. But this is nonsense. If you really count, you'll find that in some ways we are ahead and in some ways they are ahead. All together we are just about on par. Indeed, I almost have the impression that overall the West is stronger than the East, not that numerical differences carry much importance for nuclear forces anyway.

But there must also be more steps—for example, a comprehensive test ban so that the development of new weapons is largely stopped because they can't be tried out. And then, further steps would involve a slow decrease of weapons, particularly the tactical nuclear warheads deployed in Europe. They represent a very special danger because the likelihood of their use would be rather high in the event of a Soviet invasion: commanders might be motivated by the pressure of the "use-them-or-lose-them" syndrome and the level of nuclear exchanges might then escalate out of control. This is why I am so strongly in favor of

People must understand the tremendous danger of nuclear war, but that's not enough. We also have to show that it is possible to get *rid* of the danger.

a "no-first-use" pledge by all governments.

To Minimize the Danger: A Selective Farewell to Arms

MARCUS: Assuming that the quest for immediate personal gain is not involved, what could be motivating people—particularly the leaders in Washington—who are moving to *increase* the number of nuclear weapons?

WEISSKOPF: It's a matter of interpretation. You could make a case just like any lawyer can make a case: you could simply point out that here and here and here the Russians are ahead of us, without mentioning that there and there and there we are ahead of *them*. Why do they do this? I am not a psychoanalyst, but if I may guess I would say first it is out of personal fear—individuals in charge of a particular type of armament are afraid that they will be blamed later on if the Russians have more of that weapon than we do. Second it is out of political fear—that the Communists are out to snow us under and become the world leaders. And so, they say, we must be stronger. But the fact is that the Russians are just as afraid of us as we are of them.

We must not forget, however, that the Soviet regime is a terrible one: it cruelly persecutes and often arrests those who openly dissent, it violates the civil rights of Jews and other minorities, and it limits free speech, choice of profession, and travel both abroad and within the country. Most Western democracies are infinitely superior. The Soviets have also taken numerous repressive actions outside their country—in Czechoslovakia, Hungary, Afghanistan, and Poland, for example. But here, I am sorry to say, the Western record is not so spotless either. Think of Vietnam (our "Afghanistan") and the American support of oppressive military regimes in El Salvador and Guatemala. We and they keep acting out of fear, trying somehow—by *any* possible means—to gain political advantage.

So those people who believe that simply by being stronger we can force our will upon the Soviets are misguided. But let's also examine what it means to be "stronger." We're talking about nuclear weapons, where it doesn't make a damn bit of difference whether you have a thousand or ten thousand or fifty thousand bombs. Two hundred would be more than enough to destroy all major cities in the other country. So what does it mean to have more? Nothing. That is the madness of the arms race.

MARCUS: Personally, I wouldn't feel all that much calmer with two hundred weapons pointing this way than with ten thousand—any *one* would be devastating. Do you think it will ever be possible to achieve a complete disarmament, to actually dismantle nuclear weapons and go down to zero?

WEISSKOPF: No, because then both sides would live in fear of the other having secretly accumulated a few hundred of them. But *reducing* the number is possible, and that could have a beneficial effect not only numerically but psychologically. Our land-based missiles, for instance, which contain a quarter of our strategic weapons, are a tempting target for the Russians and a haunting presence for everyone living east of the launching pads. (The radioactive plume of only a few hits, driven eastward by prevailing winds, could kill hundreds of thousands of people rather quickly and produce environmental contamination that would later kill thousands more.) Given our missiles on submarines and airborne bombers that are much more difficult for the Russians to locate, the land-based leg of the "triad" is virtually useless and unnecessary. We should scrap it altogether—and soon.

Another important reduction could involve tactical nuclear weapons—for use, presumably, on the battlefield only. But if there is ever a war in Europe or the Middle East and people start to use them, there is probably no way of limiting the war—the losing side could keep upping the ante until we are in the midst of a holocaust. I say *probably*, of course. There is maybe a 10 percent chance that the war could be limited, which means there is a 90 percent chance that the world would come to an end. Now is that any way of running the show? Some people maintain that tactical nuclear weapons deter any conventional aggression. But it would be far better to deter such aggression by conventional means.

MARCUS: Do you mean that a smaller power's nuclear actions could trigger all-out nuclear war? Despite the "rational" decision making in Washington and Moscow, could it really be in the hands of someone like Libya's Kadaffi?

WEISSKOPF: Not quite. If smaller nations acquire nuclear weapons—following the unfortunate example that the big powers set for them—they would still have only a few. And if these weapons were used, it

Some people maintain that tactical nuclear weapons deter conventional aggression. But it would be far better to deter such aggression by conventional means.

would be a great catastrophe, but it would not necessarily bring on the holocaust. That would occur only where the superpowers were directly involved—say, in Europe. Now I am not arguing in favor of nuclear bombs for the small powers. We should certainly do what we can to prevent that, and we really don't do enough to prevent the use of reactors for bomb making. But I don't see the main danger there.

MARCUS: What about an "accidental" attack—caused by technical malfunction or "human error"—among the superpowers?



WEISSKOPF: Pentagon people maintain—but I don't really believe it—that our launching pads are so safe, and our submarines are so safe, etcetera, etcetera, that this could never happen. Haven't computers gone wrong before? And what do we know about the Russians' launching procedures? Most probably they are less safe than ours. I think there *is* a big danger of accident and that is one very good reason for decreasing the tension between the United States and the Soviet Union. As long as there is good communication between the two countries and a reasonable spirit of détente, an accidental launch might cause a catastrophe, but not the final catastrophe.

Despite the occasional talk of "winnable" nuclear war, most people realize that one superpower simply cannot destroy the other without being destroyed itself. An intentional first strike is really out of the question, but we cannot exclude the danger of a precipitating "accident." We can only *minimize* this danger by minimizing the number of nuclear weapons and by reducing the probability that they are used. This speaks for the elimination of tactical weapons as well. And all this is possible only by working toward détente. Successful negotiations are our only hope.

A Weapon to End All Wars?

MARCUS: I'd like to look back a little by asking about your Los Alamos experience. The great incentive for the Manhattan Project, it seems, was the German threat—the fear that the Nazis would develop the atomic bomb first. Yet when it became clear that the Germans were not even close, and after they were defeated, the work continued. Most of the individuals at Los Alamos were hardly stereotypical cold-blooded scientists—they seem to have been, by and large, warm and sensitive people—yet they just kept right on working, a group of "the best" creating "the worst." What motivated them after the threat was gone?

WEISSKOPF: Let's not forget that even after the Germans were defeated we were still not sure the bomb would work. There was still the possibility that neutrons would be absorbed too strongly to permit a chain reaction, and we all hoped that this would be the final result—that such a bomb could not be made at all. That hope, of course, was quashed. But then why did we go on? Maybe because it's a human kind of drive: when you're almost finished with something you keep on going until you finish it. But we also believed that if such a weapon were possible it would eventually be built by somebody else, and therefore let us better develop it here because we had such great confidence in the United States. But perhaps we were naive: many of us thought the weapon was so terrifying that it would have to be "internationalized"—that

As long as there is good communication between the US and USSR, and a reasonable spirit of détente, an accidental nuclear launch might cause a catastrophe, but not the final catastrophe.

it would compel all nations to get together. We even proposed an international administration, and we thought that surely the Russians would participate because it was the same threat to them as to us. But people who knew Stalin and the Soviet system certainly could have told us that the Russians would never accept such arrangements.

MARCUS: Even without a Stalin, have leaders ever been willing to abandon nationalism? Even with the sudden "millionfold increase in the power of technology," as you've called it, how likely was it that politics could change that quickly and drastically?

WEISSKOPF: Changes *have* occurred in human affairs, both slow and fast ones. It is becoming increasingly apparent that individuals, cities, and states must help one another. Sure, one can easily take a pessimistic view: that we've always had wars, that the most effective weapons have always been used, and therefore that there is absolutely no hope of avoiding nuclear catastrophe. But we are now at a point where things are qualitatively different from all that has gone before, and this gives me reason to hope that there will be a fundamental change in attitude toward war.

Whenever I visit Europe, I think of this. When I go to Florence and then to Siena, in Italy, for example—they are just 50 kilometers apart—I recall that they used to have terrible wars. Other neighboring cities in Europe have similar histories. But in time such conflicts ended and were replaced by wars between larger countries. And now, wars between European countries no longer seem likely. Instead, we think in terms of "intercontinental" wars. But given this progression, and the finite radius of the earth, and the terrible, long-range power of nuclear weapons, it's possible that the whole idea of war may become senseless. The question is: will it become senseless before or after the Third World War?

Scientists' Bridge over Troubled Waters

MARCUS: Given its patterns of collaboration both domestic and international, do you see the scientific community serving as a model for better understanding among nations? In many ways, the Manhattan Project was a great, perhaps unprecedented, success in terms of its team spirit and technical accomplishments. And it has struck me that in many of your professional activities since then you've tried to recreate that spirit for more humane applications. You've described the work of CERN [European Center for Nuclear Research, in Geneva] for example, as participatory, cooperative, unselfish, exciting, rewarding, international. And it seems that you're almost uniformly in favor of nonmilitary scientific exchanges between East and West for the same reason.

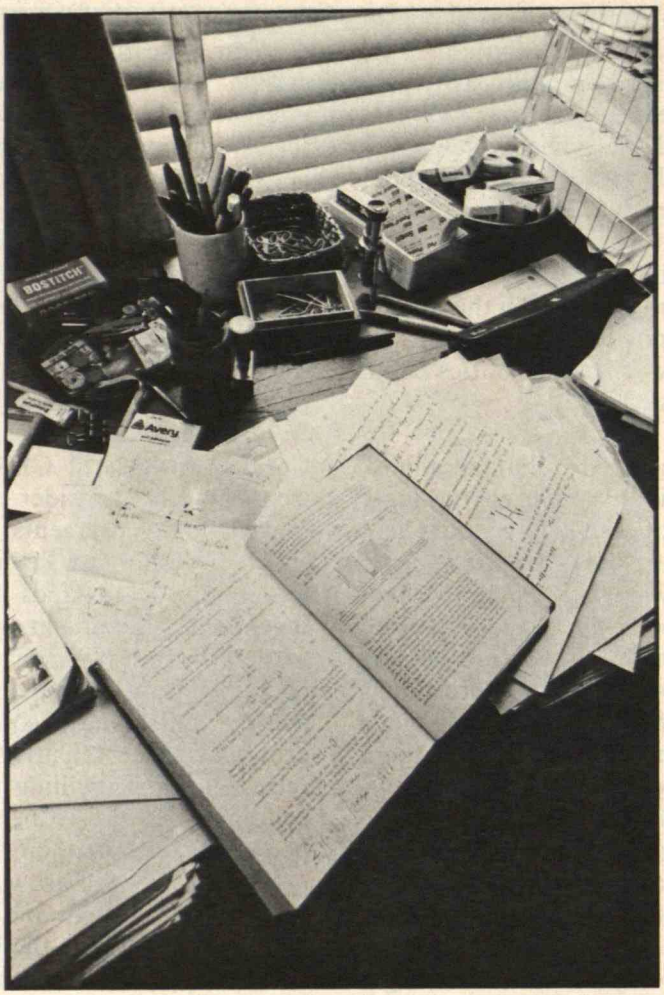
WEISSKOPF: Absolutely. I don't want to imply that the scientific community is better or more advanced than any other group, but it does have a little more experience in international collaboration. I'm worried, though, that present trends may curtail this. During the so-called détente we had quite a few scientists from the Soviet Union and other Eastern countries working with us at CERN, and it went extremely well. Indeed, I consider this collaboration one of my important achievements there. But now the atmosphere is different. People are angry at the Soviet leadership for all kinds of things—from civil rights (such as anti-Semitism and the Sakharov oppression) to the invasion of Afghanistan and the Soviet influence in Poland. These are certainly serious political matters, but I find it completely wrong when physicists and other scientists react by declaring themselves no longer willing to work with their Russian colleagues. And I've been trying to convince these people to continue their collaborations.

First of all, who are we to cast stones? The situations in Afghanistan and Poland, as bad as they are, are not unlike things the United States has done. The terrible oppression within the Soviet Union and the infringement on human rights are, in my view, a reason to keep *up* our relations. Ironically, the scientific community in the Soviet Union is probably the "best" in the country—the most sympathetic from a moral and political point of view. It shares, in large measure, the Western value system. To cut off connections with them now would be counterproductive. And if we stop collaborating with them, they will lose the little hope they have. The window to the West will be closed.

But not only will this gesture hurt science and international communications, it won't make a bit of difference to the Soviet leaders, who simply do not care about international collaboration in basic science. They do care, of course, about military applications, but these are pursued by an altogether different scientific group. Whether or not the USSR's particle physicists or solid-state physicists work with their European and American colleagues is a matter of relative indifference at the Kremlin. So this "pressure" to

The only link we have for the future is collaboration, in science as in sports, and to break this off, to my mind, is a very big mistake.

force the Soviet government to change its policies will be useless and simultaneously burn important bridges. The only link we have for the future is *collaboration*—in science, as in sports—and to break this off, to my mind, is a very big mistake.



MARCUS: You've often referred to science as "supranational" or "supraideological." But do you really think that science is any more immune to outside political pressures, or its own internal political pressures, than other human activities?

WEISSKOPF: No, of course not. Scientists are just as subject to political trends and ideas as other people. But science, perhaps together with sports, can really be supranational because its aims, language, and style are the same for all nations. It is much easier for scientists or athletes from different cultures to understand one another than it is for lawyers or politicians, for example. And in fact, experience has shown that the scientific community has been a very good bridge between different ideologies.

MARCUS: Science may be a model for building bridges, but I worry about some of the great popular misconceptions: that science is supposedly apolitical and value-free; that all R&D is part of some inexorable progress; that if a scientist is involved it must be all right . . .

WEISSKOPF: Yes, people debate whether science and technology are dictated by human needs or whether they are expressions, as you say, of some inexorable progress that we cannot control—and that may bring us, through the development of nuclear weapons, to the abyss. The danger, I think, is not in science per se but in its possible domination of other ways of thinking. This is a danger that humankind has always faced, and suffered from, and that scientists and technologists ought to be aware of: when one idea suppresses all others it leads to abuses. Think of the influence of religion during the Middle Ages—of the millions of deaths, and indifference to suffering, in its name. I'm not antireligious, but if religion is the dominant way of thinking, as with any other predominant view, we get exaggerations, abuses, and catastrophes.

The same is true of technological development. We certainly live in an age in which it is overvalued. And just as religion serves some purposes admirably and others poorly, so we should think about certain technical applications as reasonable and others as not reasonable at all.

Whenever one way of thinking has been developed with force—even claiming to encompass all human experience—other ways of thinking have been neglected. This has its roots in a strong human desire for clear-cut, universally valid principles containing answers to every question. But because human problems always have more than one aspect, general-purpose answers do not exist. The aim should not be to choose which viewpoint is right or wrong but to know how to decide when one or another is appropriate.

And I'm not just talking about weapons. Look how commercial interests can produce serious pollution problems through one-sided thinking—the buildup of carbon dioxide in the earth's atmosphere, for example. An equilibrium among technical, scientific, and moral values is certainly necessary.

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MARCUS: You've often referred to a second kind of pollution, what you call "spiritual pollution," of which the "triumph of craziness"—neither side knowing where to stop the nuclear arms race—is a notable example. Given its ideology-bridging property, can science play a useful role in helping to abate this "spiritual pollution"? Can science serve as a model for global-scale collaboration, in the spirit of Los Alamos or CERN, involving all kinds of human knowledge and interests?

WEISSKOPF: I think that public opinion, not the activities of the scientific community, will be the critical factor. And I would take as a model not CERN or other international endeavors but the public reaction to the war in Vietnam. Logically, militarily, and politically it should have gone on and on, but public opinion turned against it. People realized that what we were doing there was wrong and they eventually brought it to a stop. This was an instance where "superlogic" (which in fact was madness) was turned around by the public's reasonableness, and this is my hope for the nuclear case, too.

There's another reason why the scientific process should not be a model for combatting "spiritual pollution." Public opinion, as with the anti-Vietnam-War movement, can never be purely rational. It is fundamentally emotional, and here rational thinking, moral thinking, religious thinking, and so on must all come together in a constructive way. I have always said—*preached* is more like it—that the scientific/technical way of thinking is only one approach to the problems of humankind and the human experience. There are other avenues to problem solving such as art, poetry, morals, ethics, and religion. All these different approaches are necessary to have a mass movement that is really effective. It must be based on all these things, on the beauties of life itself, if the spiritual pollution we mentioned is to be eliminated.

But fundamentally, people must see some sense in life. I was very disappointed that my good friend Steven Weinberg, who wrote this wonderful book *The First Three Minutes*, made a terrible statement in its final pages: "The more the universe seems comprehensible, the more it also seems pointless." I believe strongly in exactly the other way. Science *does* give us a sense of purpose. When you look at the development of the universe, from the "big bang" to sentient beings, there is clearly a pattern. There is something that develops, something in nature that is creative. Science, of course, is not the only way of giving sense to our lives. Art does it; so does religion. But when this sense is missing, that's when spiritual pollution is present—when people don't know why they are here. We can have leisure-time diversions, of course. But until we learn to fill the vacuum in our minds with *content*—with meaning, with sense—we will never find solutions to our problems.

MARCUS: And how do you see that happening?

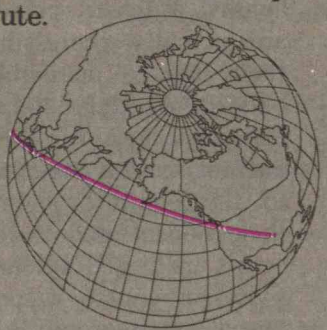
WEISSKOPF: By developing new creative outlets, not only for the scientist and the artist but for everybody. Here again I am relatively optimistic. When my wife and I came here 45 years ago, we didn't encounter very many people during our walks in the mountains of Vermont and New Hampshire—and the few we did meet had German accents. But now you'll find a great many people—young and not-so-young Americans—on the trails. For them, contact with nature has become one way of filling their souls. There are other ways, of course, some more intellectual and some more social in flavor (such as helping other people to cope with their problems). We have to find them and develop them. Where there is a need, there is usually a solution.

I often tell my students, when they are depressed by the world, that there are two things that make my life worth living: Mozart and quantum mechanics. What I mean is that the achievements of humankind—whether in art or in understanding nature—ought to impress and inspire people. There are so many great creations in the world that are readily



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appreciated. But a lot of education is necessary.

Appropriate Choices, Sizes and Worries

MARCUS: In dramatizing why inadequate public awareness of technical issues can distort priorities, you've often expressed dismay at public preoccupation with the risks of nuclear power and people's relative lack of concern with the risks of nuclear bombs. You've made some pretty strong statements about which system poses the greater risk—for example, that "in comparison to the overwhelming threat of nuclear war, the nuclear-power controversy dwindles to picayune dimensions." There's no doubt, of course, that this statement is true with regard to physical damage, but I worry that even though the threat of nuclear war is humanity's number-one problem, such statements trivialize all the other problems. A serious reactor mishap (from accident or sabotage), or a worrisome environmental trend, or just about any other conceivable catastrophe all would produce far less serious "impacts" than would global holocaust. But does that mean people shouldn't be concerned about them or try to take action to prevent them?



WEISSKOPF: You are touching on an important set of issues, and I fully agree with you about such problems as ocean pollution, river pollution, CO_2 pollution, . . .

MARCUS: Or *any* problem. It doesn't have to be pollution.

WEISSKOPF: Yes, of course. Social problems such as poverty or the decay of urban centers are extremely important—they're a kind of "pollution," too. I fully agree that the danger of nuclear war should not make us blind to other dangers, but ironically, many in the Reagan administration obviously disagree. They seem to argue that the Russian military danger is so great that we must put all our money there and let the poor go hungry. I've said what I have about comparing nuclear risks because I believe many of the people who have been so much against nuclear power are actually repressing their fear—a justifiable one—of nuclear bombs. Possibly because they did not see any solution to the bomb problem, they concentrated on reactors instead. Radioactivity, of course, is potentially dangerous. But people have gone to lengths that I really don't understand—and that I've criticized.

MARCUS: The concerns of the anti-nuclear-power movement, it seems to me, are not just the technological risks but the social and political aspects of nuclear power: it is highly centralized and therefore socially "unstable," highly sophisticated and therefore controlled by a technical priesthood . . .

WEISSKOPF: I don't quite agree with that. The only point on which I agree with the anti-nuclear-power people is the proliferation angle. The haste to sell as many reactors as possible to the small countries has allowed them the possibility of cheating by making plutonium for bombs. That, to my mind, is the only really serious objection to nuclear power. But the point you raise is one we simply must face anyway—it doesn't apply only to nuclear power but to any electric power station of the same order of megawatts. And I

don't really see the great advantage of dividing it into smaller parts.

MARCUS: But wouldn't you agree that decentralization has desirable implications for democratic control?

WEISSKOPF: You mean "small is beautiful"?

MARCUS: Not necessarily small, but "appropriate." You yourself have written about the great need for popularly controlled production units and the consequent "humanization" of technology—in language that could have come from E.F. Schumacher.

WEISSKOPF: "Appropriate" is the right word. You should make something big only if it is really an advantage. And you might even sacrifice some of that advantage to allow workers to participate in the administration. You may lose a little efficiency, but it will pay in the end. And the same is often true for smaller units—they may be less efficient but perhaps it is better that they are more "human-scaled." There are limits to this, however, and electric power stations, it seems to me, are more appropriately large and

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I would continue negotiating with the Soviets until we achieved a mutually acceptable reduction of nuclear weapons on both sides.

centralized. The one great advantage of nuclear power, by the way—and of fusion, if it ever comes to pass—is the alleviation of a very serious concern: the CO_2 problem.

MARCUS: You don't have comparable worries about disposal of nuclear waste?

WEISSKOPF: I worry, I worry. But at least some solutions are possible. The CO_2 problem is not comparable: if you burn coal, you must make CO_2.

MARCUS: And if you operate a nuclear reactor, you're stuck with plutonium for many thousands of years.

WEISSKOPF: I don't want to minimize the waste problem—it is a big one that hasn't really been solved. But you can at least see a direction, and some theoretical possibilities, for solutions. There is no possibility of avoiding CO_2 emissions when you stick to the old-fashioned methods of energy production.

Education: The Heart of the Matter

MARCUS: Turning to another kind of size phenomenon, what do you think is the power of the individual scientist or technologist who refuses to contribute to an enterprise—whether it's nuclear power, the nuclear arms race, whatever—that he or she considers objectionable? What do you think is the overall impact of such individual acts of conscience?

WEISSKOPF: Not much. Refusal at this point is not a way to solve these problems. Only a change in public awareness can do that. If the public is not aware of a problem, or is not motivated to solve it, you can always find people who will do the work that others refuse to do. A "strike" of scientists is a little bit like the Aristophanes play *Lysistrata*, where the women refuse to have sexual intercourse with the men unless they stop waging war. It's a sincere and colorful gesture, but it doesn't get to the heart of the problem and therefore has no lasting effect.

MARCUS: If you were given carte blanche by the president—essentially unlimited authority, time, and money—to get to the heart of the problem, right now, what would you start doing?

WEISSKOPF: Two things I would do on the very first day: scrap unnecessary and dangerous systems, with land-based nuclear bombs and tactical nuclear weapons being the first ones to go. Then I would launch a massive public-awareness drive on the threat of nuclear war, emphasizing the many ways in which it could be reduced. My hope would be to reverse the "triumph of craziness" with a more rational view. I would continue negotiating with the Soviets until we achieved a mutually acceptable reduction of nuclear weapons on both sides.

On a more fundamental, long-term level, I would put my time and money into education. Not only do we not have enough education, but we have the wrong kind. Our high schools are in a deplorable state. Science teaching in high school is especially bad, and it is driving people away from science for life. It's the opposite of "knowledge and wonder": just cold figuring-out, no awe and no joy. I would train better teachers by investing heavily in teacher's colleges, and I'd pay them well. This would apply to every level of education, right down to the earliest stages of elementary school.

MARCUS: Do you see the microprocessor's inroads into education, with more and more children having "computer literacy," as a step in the right direction?

WEISSKOPF: Any one thing has both a good and a bad side. The advantage of the computer is that it allows the gifted kids to really widen their horizons. I see it in my grandson—he doesn't buy computer games, he *invents* them. But the opposite effect also occurs: computers can repress thinking in kids and stifle their creativity. For example, it's not really necessary, with computers available, for students to know the multiplication table. And because the computer gives an exact result, they cannot estimate anymore, either. Even digital watches, for all their convenience, are actually very bad for the mind; they don't have this quantity-quality aspect. I see by the old-fashioned clock on the wall, for example, that it's *roughly*—we are nearing—five o'clock right now. "Estimation" is a very important way of looking at the world. The computer, like all useful things, can be misused.

Reliance on any one technique or any one way of thinking, whether scientific, artistic, or religious, is unbalanced and subject to abuse. We need many different approaches to cope with the predicaments of humanity, to enable people to find a sense and a purpose, and to change the attitudes that threaten the very survival of our society. In the long run, it is all a matter of education.

Misfortune Tellers

It won't work. It'll ruin the environment. It'll throw people out of work. Free enterprise can't manage it. God didn't intend us to have it. It'll kill us all.

Down-in-the-mouth forecasts like these are sometimes heard in public debates on technological undertakings, no matter how worthy. Pessimists too often seem to outnumber and outshout pioneers.

Discouraged supporters of promising innovations can take heart from a delightful book recently published in England. *Facts and Fallacies*, by Chris Morgan and David Langford, collects a number of history's misguided predictions.

Many of the items concern transportation technology. That's a field in which we at United Technologies have a special interest as designers and builders of such products as jet engines, helicopters, rockets, and aircraft and automotive systems and equipment.

A sampling of the now-amusing statements of old shows that shortsighted naysaying is nothing new—even by people who should know better:

- "Rail travel at high speed is not possible because passengers, unable to breathe, would die of asphyxia."—*English clergyman Dr. Dionysius Lardner, mid-19th century.*
- "The dangers [of gasoline-powered vehicles] are obvious... Stores of gasoline in the hands of people interested primarily in profit would constitute a fire and explosive hazard of the first rank. Horseless carriages propelled by gasoline engines might attain speeds of 14 or even 20 miles per hour... The development of this new power may displace the use of horses, which would wreck our agriculture. The discovery with which we are dealing involves forces of a nature too dangerous to fit into any of our usual concepts."—*unnamed authority, Congressional Record, 1875.*
- "Flight by machines heavier than air is unpractical and insignificant, if not utterly impossible."—*astronomer and mathematician Simon Newcomb, 1902.*
- "...ideas [of transatlantic airliners] are wholly visionary, and even if a machine could get across with one or two passengers, the expense would be prohibitive to any but the capitalist who could use his own yacht."—*astronomer William H. Pickering, 1910.*
- "...scientific investigation into the possibilities of jet propulsion has given no indication that this method can be a serious competitor to the propeller. We do not consider we should be justified in spending any time or money on it."—*Under Secretary of State, 1934.*
- "The acceleration which must result from the use of rockets...inevitably would damage the brain beyond repair."—*J.P. Lockhart-Mummery, author of a book on the future, 1936.*
- "Space travel is utter bilge."—*Dr. Richard Woolley, Britain's Astronomer Royal, 1956.*

Misfortune tellers with dark clouds in their crystal balls have always been with us. Happily, so have innovators with the vision and perseverance to reach successfully for the promise of technology.



Meeting Japan's Challenge

Fifth in a Series

ARE JAPANESE EXECUTIVES BETTER PEOPLE MANAGERS THAN AMERICAN EXECUTIVES?

Much has been written about Japanese management style.

Quality circles, lifetime employment, corporate anthems, exercise programs, etc.

The implication is that the style of Japanese management is superior to that of American management. And that for Japanese companies, this particular style works both at home and abroad.

But did you know that this style is not universally practiced in Japan? In many Japanese companies, employment tenure varies, quality circles don't exist, the boss is the boss.

And did you know that many American companies have an even better record of management than some Japanese companies? We believe that one of these companies is Motorola. Why? It all starts with our respect for the dignity of the individual employee. We apply this philosophy in many employee-related programs.

Our Participative Management Program brings our people together in work teams that regularly, openly and effectively communicate ideas and solutions that help improve quality and productivity. In the process, many employees tell us that the program also enhances their job satisfaction.



Are employee exercise programs, company songs and lifetime employment the best ways to increase productivity?

Motorola's Technology Ladder provides opportunities for technical people, such as design engineers, to progress in professional esteem, rank and compensation in a way comparable to administrators and officers.

Our ten-year service club rewards employee dedication and loyalty with special protection for continued employment and benefits. And in an industry noted for both explosive growth and high mobility, almost one-quarter of our U.S. employees have been with us for more than a decade.

Our open door policy enables employees to voice a grievance all the way up to the Chairman. It's rarely needed, but it's there. And it works. These and other programs reflect our respect for, and commitment to, the individual and the team. Their continuing effectiveness is reflected in the direct and open, non-union relationship among all our people, whether production workers, engineers or office workers. All of this works for us as we work for you.

Meeting Japan's Challenge requires an enlightened management style—demonstrated by our participative management style that respects the dignity of the individual.

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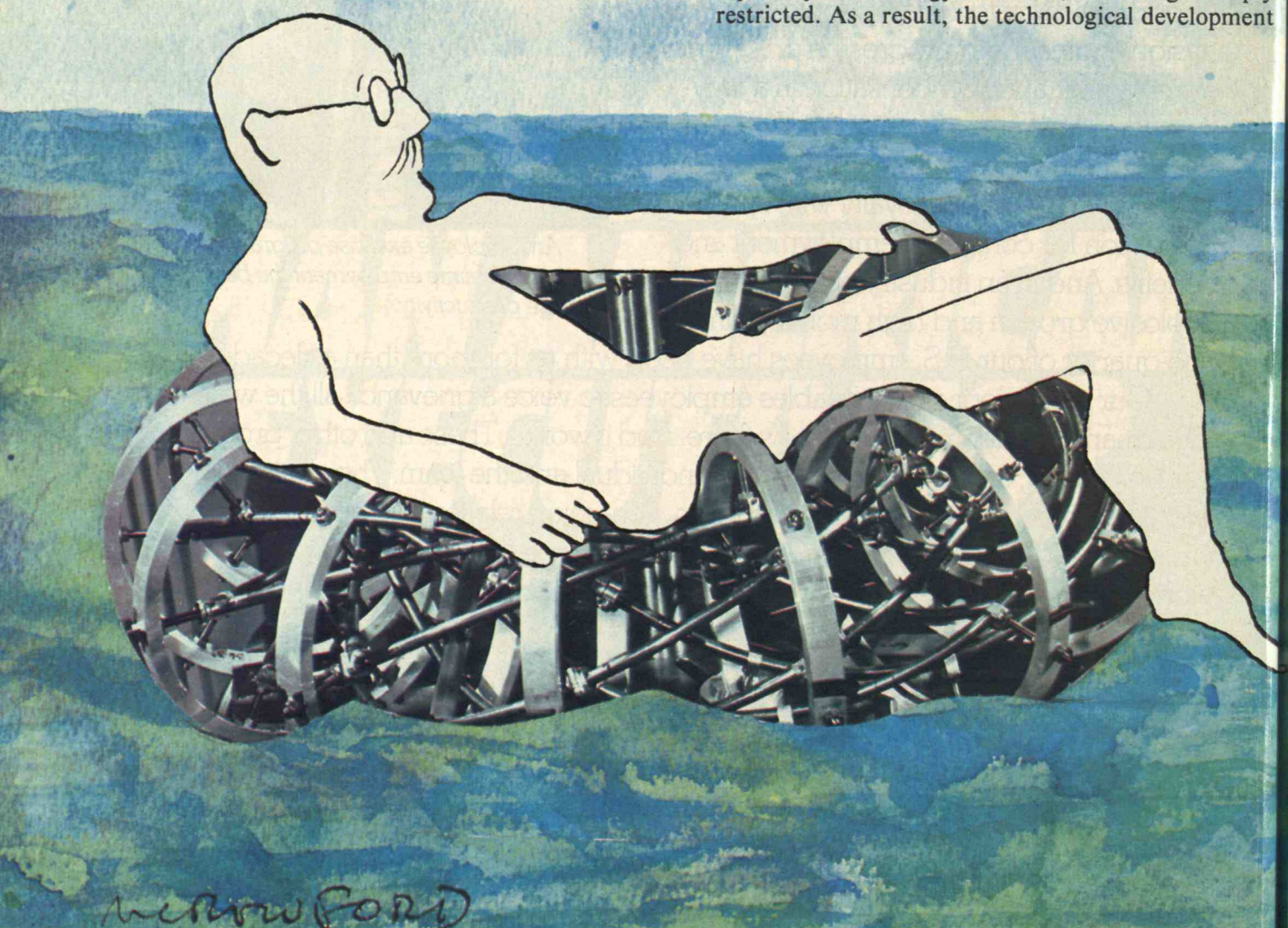
Casting Fusion Adrift

by Edwin E. Kintner

The nation's pace-setting program for exploiting the ultimate energy resource is in danger of going under.

THE development of fusion energy has reached a critical point. There is now a consensus: We can safely assume our ability to generate and contain plasmas under conditions we believe will make possible commercial energy production. We should now proceed in earnest to develop the engineering technology required to refine this scientific achievement for practical use.

But ironically, that judgment has been reached in the U.S. just when federal discretionary funding, especially for energy research, is being sharply restricted. As a result, the technological development

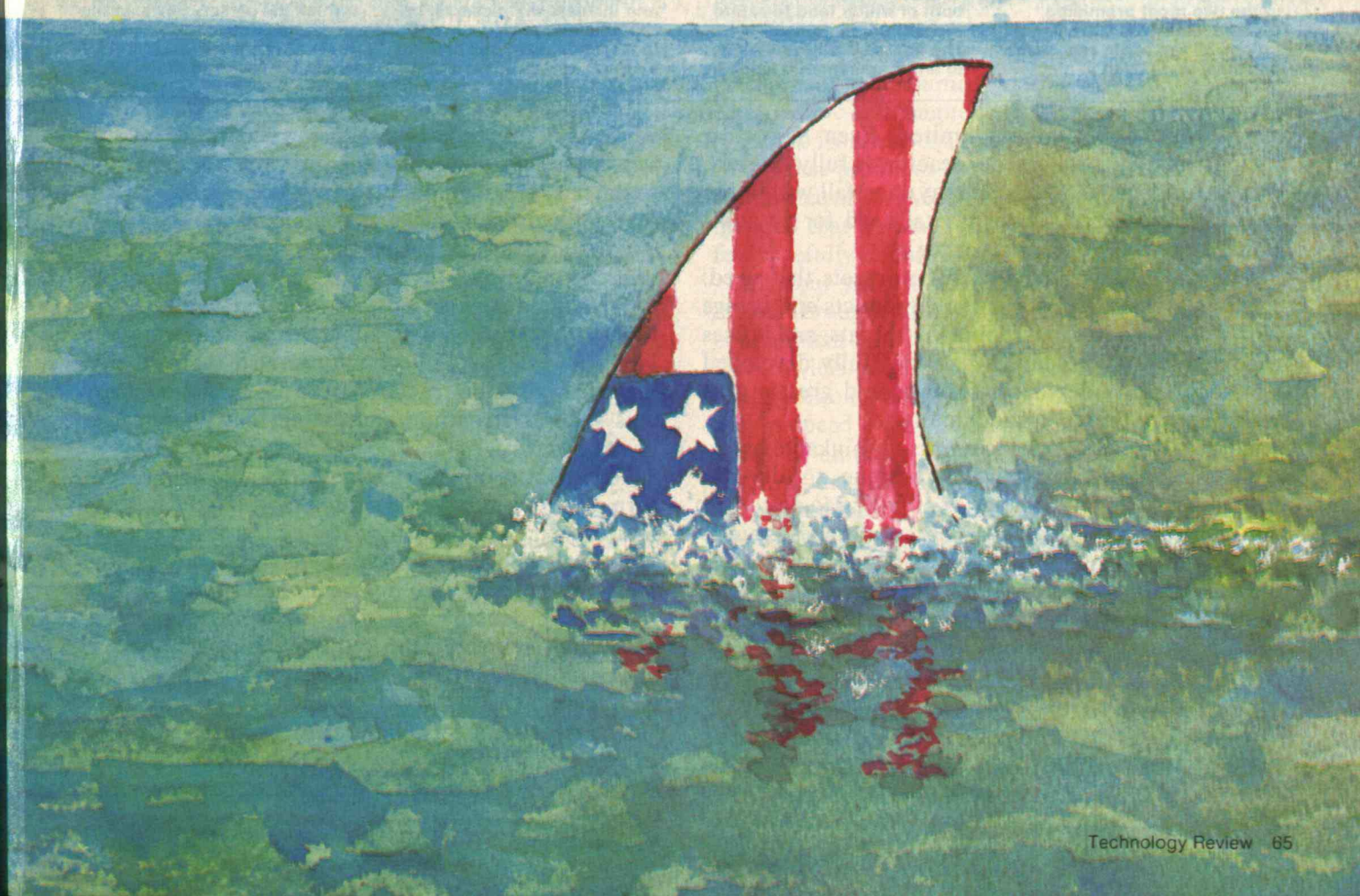


of fusion, although already planned by the Department of Energy and mandated by Congress, will be delayed indefinitely.

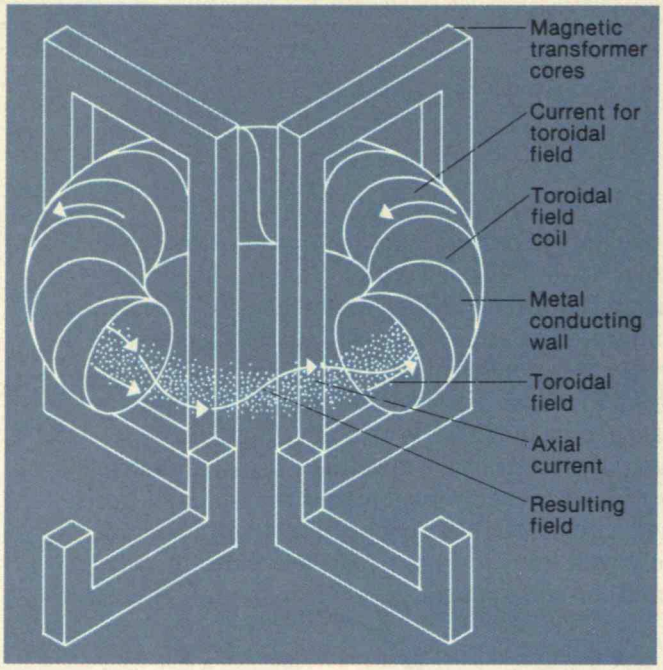
To understand the implications of this decision, it must be put in the context of our overall energy circumstances and the potential contribution of fusion.

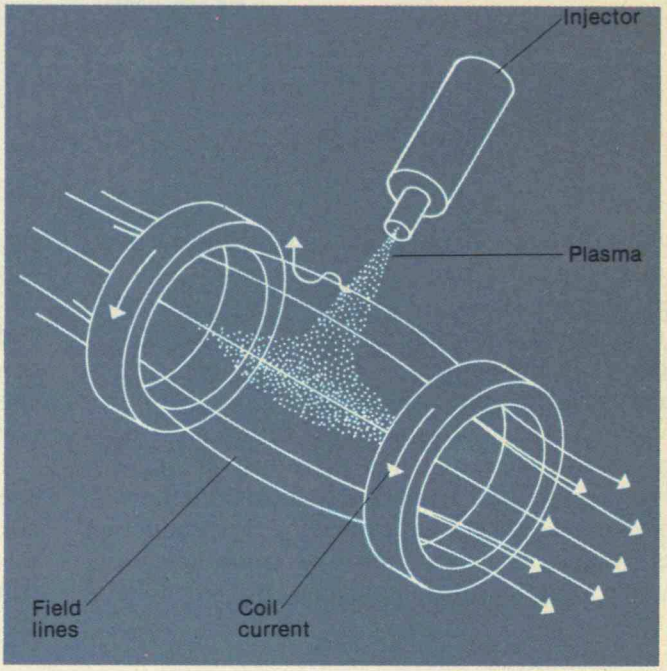
Energy is a crucial variable in the future of modern civilization, the sine qua non of industrial society. Energy provides light in darkness, heats our homes, and cooks our food. It is necessary for the production of goods, rapid transportation and communication, and modern agriculture and food processing. Its rising cost in the past decade has already slowed the economies of all industrial nations, and its geographical distribution increasingly influences diplomatic and military decisions. The most important potential trigger for thermonuclear disaster is competition for energy, and its cost and availability have become the dominant factor in Third World development.

Industrial societies have now made use of all known energy resources except fusion, and the availabilities, cost, and effects of these conventional resources are relatively well known. Fossil fuels are finite in quantitity and produce negative environmental effects;



Even if the research goes reasonably well, that achievement would require the expenditure of about $15 billion.





How magnets confine plasmas in the two most promising fusion systems. At fusion conditions all materials are plasmas, composed of electrons and dissociated ions, both of which tend to rotate around magnetic field lines. The goal of both systems is to arrange magnetic fields so that they efficiently confine and insulate the plasmas. In the tokomak device, current in a toroidal field coil creates a strong magnetic field that defines a "doughnut" through which the plasma flows. In the mirror device, circular magnets create a bundle of field lines compressed at the ends.

solar energy is useful but limited. Even if nuclear fission, including the breeder reactor, is fully utilized, the United States faces an energy shortfall within the next two decades. There is a vital need for an additional large-scale energy resource.

Controlled thermonuclear fusion meets that need. It offers greater flexibility in end products and brings with it only modest environmental threats, and it uses a benign natural resource: water. If fully developed and successfully deployed, fusion could greatly ease world energy problems indefinitely.

Under these circumstances, it is unthinkable not to deliberately but aggressively continue to develop fusion to practicality. The price of failing to do so will not be paid for many years—perhaps decades—but it will be very high. This is true even if the effort proves unsuccessful, because we will more clearly understand our limits and can better plan the use of our remaining energy resources.

How Matter Becomes Energy in the Fourth State

The goal of the fusion process is to bring together the nuclei of two or more elements under conditions where they fuse together, releasing significant quantities of energy. Since vast energies must be imparted to the nuclei, the lighter elements—especially the isotopes of hydrogen known as deuterium and tritium—are preferred. This fusion process does not release particulates or gaseous effluents. The total radioactivity generated is expected to be one-hundreth to one-thousandth that of a fission reactor producing the same power. The radioactivity is also more benign than that in fission reactors; there are no fission products such as strontium and iodine that pose special health hazards.

The most significant element of radiological concern is the tritium fuel. Tritium has a relatively short radiological half-life (14 years) and a much shorter biological half-life (approximately 12 days), and therefore poses a very different threat from that of the waste products of a fission reactor. A fusion reactor would lack sufficient fuel for a runaway nuclear explosion and contain insufficient residual heat for a core meltdown.

To fuse, the nuclei of light elements must be heated to very high temperatures—around 100 million degrees, or five times the temperature of the sun's

If fully developed and successfully deployed, fusion could greatly ease world energy problems indefinitely.

core—and confined at high pressures. Under these conditions, all materials are plasmas—the so-called "fourth state" of matter in which electrons are dissociated from their nuclei. Such a mixture of charged particles can be confined in one of three ways: by gravitational fields such as those of the sun and stars, by inertial reactions as used in thermonuclear bombs, or by magnetic fields. The first method is impractical on Earth because it requires masses as large as the planet Jupiter. The second is being investigated as a part of U.S. defense research. The third—the most practical—is the subject of the Department of Energy's magnetic fusion program.

Present systems for magnetic confinement of plasmas are based on the fact that charged particles such as ions and electrons tend to rotate around magnetic field lines. Thus, to confine plasmas, scientists seek to construct containments of such field lines—either in doughnut-shaped forms (toruses) or bundles of lines squeezed together at their ends (mirrors). But the confinement is temporary; even with very strong magnetic fields, the plasma particles tend eventually to drift across the field lines and escape. The problem is to find arrangements of magnetic fields in which plasmas can be confined and heated enough to reach the temperatures and pressures adequate for fusion with a net energy gain.

Developing and commercializing this process is a difficult technical task. Fusion research has been underway for 30 years, and another 20 years may be required before its practical usefulness is actually first demonstrated. Even if the research goes reasonably well, that achievement would require the expenditure of about $15 billion. These requirements of time and money are not easily met by a political system that tends to emphasize fast payback, low risk, and flexibility. This difficulty is probably fusion's greatest problem.

Though fusion energy is many years away, our investment in the strong, aggressive program begun during the crisis of the oil embargo of 1973 has brought significant returns. The United States has assumed prestigious world leadership in this advanced scientific field, a leadership held until 1973 by the Soviet Union. This effort has resulted in new developments in many areas in addition to high-temperature plasmas, including superconducting magnets; high-temperature, irradiation-resistant materials; high-voltage, high-power electrical equipment; and mathematics and computational techniques. This advanced work has already yielded valuable industrial spinoffs that have helped maintain U.S. technological leadership and economic strength, and fusion research and development will continue to have this kind of payoff in the future. In fact, no other energy or defense program contributes as strongly to broad, long-term research needs—the kind of support provided in past years by nuclear energy, radar, and space research. This continued leadership has substantial practical value for the United States, especially in a period when the country's technological position seems to be eroding.

A Decade of Ever-Increasing Optimism

The fusion program began in 1951, when a number of scientists, notably Lyman Spitzer at Princeton, noticed that magnetic fields diverted and constrained plasmas in solar flares and the aurora borealis. It was a time of great confidence in nuclear science spawned by the successful development of nuclear weapons, and the problem of confining plasmas at high temperatures and densities for the fusion reaction was tackled with optimism.

But by 1959 there was growing pessimism. Instead of acting as a mixture of discrete particles as early researchers had assumed, plasma exhibited collective electrostatic and magnetic instabilities that allowed it to escape from the confines of magnetic field lines. By 1965 these problems seemed so difficult that a review committee of the Atomic Energy Commission recommended that modest research be continued only in a few carefully delineated directions.

But four years later, the Soviet physicist L. Artzimovich brought to M.I.T. information about plasma containment in a new device called the "tokamak." The Soviets used the same toroidal magnetic-field configuration studied in the U.S. for many years, but they induced a very high current—hundreds of thousands of amperes—in the conducting plasma. The resulting magnetic field around the torus had a helical shape that greatly improved its ability to contain the plasma at higher pressures and temperatures.

U.S. physicists immediately turned to tokamak research and confidence soon grew. Indeed, by 1973, as part of Nixon's Project Independence, the U.S. embarked on a strengthened fusion program with the tokamak confinement concept as its central thrust.

The U.S. program has since progressed rapidly, with almost continuous exponential improvement in all the main aspects of fusion confinement. Scientists have now obtained temperatures in the area of con-

Controlled thermonuclear fusion brings only modest environmental threats and uses a benign natural resource.

finement of 80 million degrees. (The minimum ignition temperature is 45 million degrees, and 100 million degrees is necessary for a practical reactor). The degree of confinement of the plasma by magnetic fields is now within a factor of 5 to 10 of that desired for a practical reactor, and the laws of plasma confinement are now sufficiently understood so that remaining improvement can be assumed. In fact, three experimental tokamak devices expected to generate and contain plasmas at the conditions required for a power reactor—the Tokamak Fusion Test Reactor at Princeton, the Joint European Torus at Culham Laboratory in England, and the JT-60 in Japan—are now under constuction.

The effort to develop a "mirror" of magnetic-field lines to confine the plasma has also made remarkable progress in the last two years, and a comparison between tokamaks and mirrors should be possible by the mid-1980s. There are also efforts to develop several smaller confinement systems. The most important is the Elmo Bumpy Torus in which a number of mirror cells are arranged in a toroid so that the losses from one cell are picked up in its adjoining cells.

Obviously, the intent of the U.S. plasma physics program has not been to press forward at maximum speed by concentrating only on tokamaks as the lead concept. Rather, the goal has been to generate a broad spectrum of knowledge of plasma confinement by magnetic fields so that the we can select the best, most useful arrangement and then efficiently perfect it.

The plasma confinement problem can be thought of as a giant jigsaw puzzle. As scientists gain additional understanding, they are able to gather its pieces together in clumps, some of which—such as the tokamak clump—are larger than others. Just as progress accelerates as the jigsaw puzzle nears completion because remaining pieces fall into the puzzle more rapidly, so progress is accelerating in plasma containment. The several lines of plasma-physics development have converged, and now much of what has been learned about mirrors or tokamaks or Elmo Bumpy Toruses is directly useful in the other confinement concepts. The experimental devices now in place or under construction, and the relatively inexpensive modifications possible over the next decade, should give us the insights necessary for fusion to become a practical success. We will need continued research for the rest of the century to reach highest efficiencies, but a successful end can be predicted with great confidence.

An Unprecedented Technological Challenge

With this assurance we can begin to work in earnest on the new engineering technologies involved in fusion reactors. There are two main objectives: to provide the higher-powered magnets, plasma heaters, and instrumentation for continued advances in plasma-physics research; and to solve the major technological problems in building practical, power-producing reactors using the fusion principle. These engineering tasks will probably require greater effort than the purely scientific development now coming to fruition.

The U.S. program in magnetic confinement, which has already provided the basis for the recent success in plasma temperature and pressure, is the strongest in the world. Meanwhile, our technology program has made a good start by identifying many engineering requirements, and some preliminary programs and facilities to fulfill them are now in place or planned.

The foremost engineering challenge involves structural materials. Almost without exception, new technologies succeed or fail because of materials. Jet aircraft would have been impossible without lightweight, strong aluminum alloys and high-temperature materials for engine blades, fission energy required the development of zirconium and its alloys as fuel cladding materials, space exploration was based on the development of a variety of new materials for rocket engines and ablation shields, computers and modern electronics were made possible by the development of semiconductors. Most of these materials will be essential in fusion technology.

There will also be new and difficult materials challenges: the environment surrounding a burning fusion plasma will contain large concentrations of high-energy neutrons, and no materials now exist that adequately resist deterioriation by high-energy neutron fluxes. In addition, materials are needed for blankets and shields, between the plasma wall and the magnet structure of the fusion reactor, that can absorb and transmit the heat to the power-producing machines while protecting the magnets and breeding tritium fuel. Studies of the engineering requirements for these components are only now beginning.

Obtaining economical fusion energy will also depend upon constructing superconducting magnets of larger size and power than have yet been built. A good start has been made in the development of magnets for the T-7 tokamak in the Soviet Union and for other fusion machines in the United States, and it now

Our investment in a strong fusion program began during the Arab oil embargo of 1973 and has already yielded significant industrial spinoffs.

appears that such magnets can be built. However, a great deal more development and operating experience will be needed.

An operating fusion power reactor will become radioactive—not as strongly as the core of a fission reactor, but enough so that maintenance and repair will have to be done remotely or from behind radiation shields. This problem will be encountered for the first time with the Tokamak Fusion Test Reactor now under construction at Princeton, and considerable development will be required before fusion power reactors can be properly maintained.

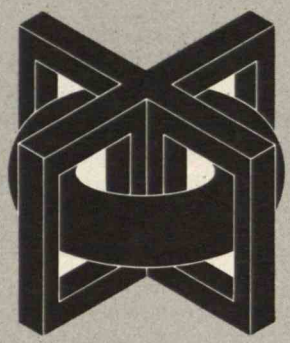
A Congressional Mandate

The recent advances in plasma confinement and the resulting increased interest in fusion have led to a number of independent reviews of the fusion program. The first was initiated by the Department of Energy in 1978 and chaired by John Foster, former head of research and development in the Department of Defense who is now vice-president of TRW. Among the conclusions of this group: "The first objective of the program must be to determine the highest potential of fusion as a practical source of energy. There is an urgent need to answer the questions concerning feasibility, and . . . there must be a major increase in emphasis on engineering problems to provide the basis for proceeding to the choice of a prototype reactor."

The Department of Energy responded to these recommendations with a Policy Statement on Fusion, the first of its kind on any energy technology: "There is no lead time to spare. If fusion energy is to be available when it is needed, the research and development program, rigorously directed toward the goal of commercial utility, must be undertaken in earnest now."

Following these recommendations, the magnetic mirror program was strengthened by a decision to build a major test facility, and an experimental Elmo Bumpy Torus facility was also launched.

In early 1980, Congressman Mike McCormack, chairman of the House Subcommittee on Energy Research and Production, organized a Fusion Advisory Panel of distinguished scientists to hold special hearings on the status of the U.S. fusion program. The panel concluded that "very significant recent technological progress in fusion research" warranted "an engineering thrust centering on an engineering test facility. . . . Our panel believes that fusion can be



Six Policy Imperatives for Fusion Success

GIVEN present constraints, what should be done to assure an effective program to assess and develop the future contribution of fusion to world energy needs?

The following six steps are essential:

☐ A wider public understanding of our present and likely future energy situation, and the significance of fusion within that context, must be encouraged. Such public understanding can be developed only with the active participation of all media and by unremitting efforts of knowledgeable citizens in all parts of society. It is surprising and troubling that fusion has no vocal proponents at influential levels of American life.

☐ A new strategic timetable for fusion development, dictated wholly by technical objectives and not short-term political considerations, should be established as soon as possible. The plan should emphasize pursuit of all aspects of fusion engineering research, including a Fusion Engineering Device.

☐ The United States should take the lead in making fusion an international project by sharing its knowledge with other nations and delegating responsibility for some research areas. Fusion research could provide a unique precedent for international technical efforts in many fields of common concern, such as acid rain and the buildup of atmospheric CO_2.

☐ Industrial participation in fusion research should be encouraged and expanded. If fusion is to contribute to industrial technology and become a practical energy resource, industry must be involved, especially if it is to make large investments of capital and personnel.

☐ The fusion program should develop a strong organizational structure independent of short-term energy programs in sponsorship and funding. Fusion has not done well in competition with other energy technologies and science programs because it does not promise immediate—or even certain—benefits.

☐ The safety and regulatory programs governing fusion must be independent of those controlling fission reactors and not simply an addition to existing programs of the U.S. Nuclear Regulatory Commission. The safety concerns of fusion are unique, and experience and practices with present reactors would not be appropriate precedents.—*E.E.K.* ☐

made commercial before 2000 if a national commitment is made soon."

The Department of Energy chartered another thorough scientific review of the magnetic fusion program later in 1980, this time by a panel headed by Solomon J. Buchsbaum, vice-president of Bell Telephone Laboratories who was then chairman of the DOE's Energy Research Advisory Board. A broadly experienced group of scientists and engineers, the Buchsbaum panel has been called "the most powerful group of its kind ever assembled for a scientific program review." Its major recommendation was that "a broad program of engineering experimentation and analysis under the aegis of a Center for Fusion Engineering" be established to achieve economically feasible magnetic fusion.

A key element of the program would be construction of a Fusion Engineering Device to "provide a focus for developing and testing reactor-relevant technologies and components" and to help "explore and firmly delineate problems of operator and public safety." Such a device should be in operation within ten years, the Buchsbaum panel said, and the cost was estimated at "not more than" about $1 billion (in 1980 dollars). Achieving these goals, said the Buchsbaum panel, would require "a doubling in the size of the present fusion program in five to seven years."

Following this report, the U.S. Congress enacted the Magnetic Fusion Energy Engineering Act of 1980, which declared that U.S. policy is "to accelerate the national effort in research, development, and demonstration activities related to magnetic fusion energy systems. . . . To ensure the timely commercialization of (such) magnetic systems, the United States must demonstrate at an early date (their) engineering feasibility." The act recommended 25 percent increases in magnetic fusion budgets in each of the first two years of the new program.

With the coming of the tokomak in 1969, fusion had been given mission orientation; the goal was—naively, I think—to compete with other energy forms in the commercial market at the earliest possible time. But this simplistic approach failed to reflect the technical difficulties involved in obtaining energy from fusion. The studies of 1978-80 were far more sophisticated. They focused on the vital issue of determining as soon as possible whether fusion can be counted on as a long-range energy resource, and they set as the major near-term goal the confirmation of both the scientific and technical feasibility of fusion by the early 1990s.

Technology Lost in the Budget Battle

Recent implicit and explicit decisions have dimmed the prospects that the strategy and timetable mandated by the Energy Engineering Act can be carried out.

The initial budget request by the Magnetic Fusion Program Office for 1981-82 was $525 million. This included strong support for two new projects in the scientific program—proof of the Elmo Bumpy Torus principle and construction of an Advanced Toroidal Facility to consolidate what has been learned about tokamaks and other toroidal systems worldwide. It also included funds for construction of a Fusion Materials Irradiation Test (FMIT) Facility, the only project anywhere in the world capable of irradiating materials at the high neutron energies and fluxes of fusion reactors, and $33 million to establish a Center for Fusion Engineering and begin in earnest the design of the Fusion Engineering Device.

The Office of Management and Budget reduced this request by $18 million before it went to Congress as part of President Carter's 1981 budget, and it was later further reduced by the Office of Management and Budget to meet the Reagan administration's guidelines. Thereafter, a series of step-by-step reductions in fusion budget plans for 1981-82 and 1982-83 made it clear that the strategy and timetable for fusion set forth by the 1978-80 studies could not be maintained. The amount available in the 1981-82 budget for the Center for Fusion Engineering was cut to $9.1 million, allowing only for organizational expenses and conceptual design activities. The new proposals effectively canceled the Fusion Materials Irradiation Test Facility, despite the fact that materials development has been recognized for years as the most difficult, longest-term technological problem in fusion. The Elmo Bumpy Torus program received sufficient funding to move ahead at half pace, but the new initiative in toroidal confinement was canceled. Congress reinstated $14 million for the FMIT, and the 1982 fusion budget was settled at $456 million.

The initial request by the fusion program office for 1982-83 was for $596 million. At this level, all the steps required by the Magnetic Fusion Energy Engineering Act could have been modestly reinitiated, including establishing the Center for Fusion Engineering, beginning the long-term research to obtain competitive designs for a Fusion Engineering Device, and continuing a strong physics program.

The Department of Energy's review of these pro-

Thirty years of progress in magnetic fusion energy research. All four of the conditions believed necessary for the self-sustained fusion reaction required for useful energy production are now being approached under laboratory conditions, and successful achievement of all four is predicted with great confidence. There remains the task of developing the technology to harness these extraordinary reactions in machines of commercial scale.

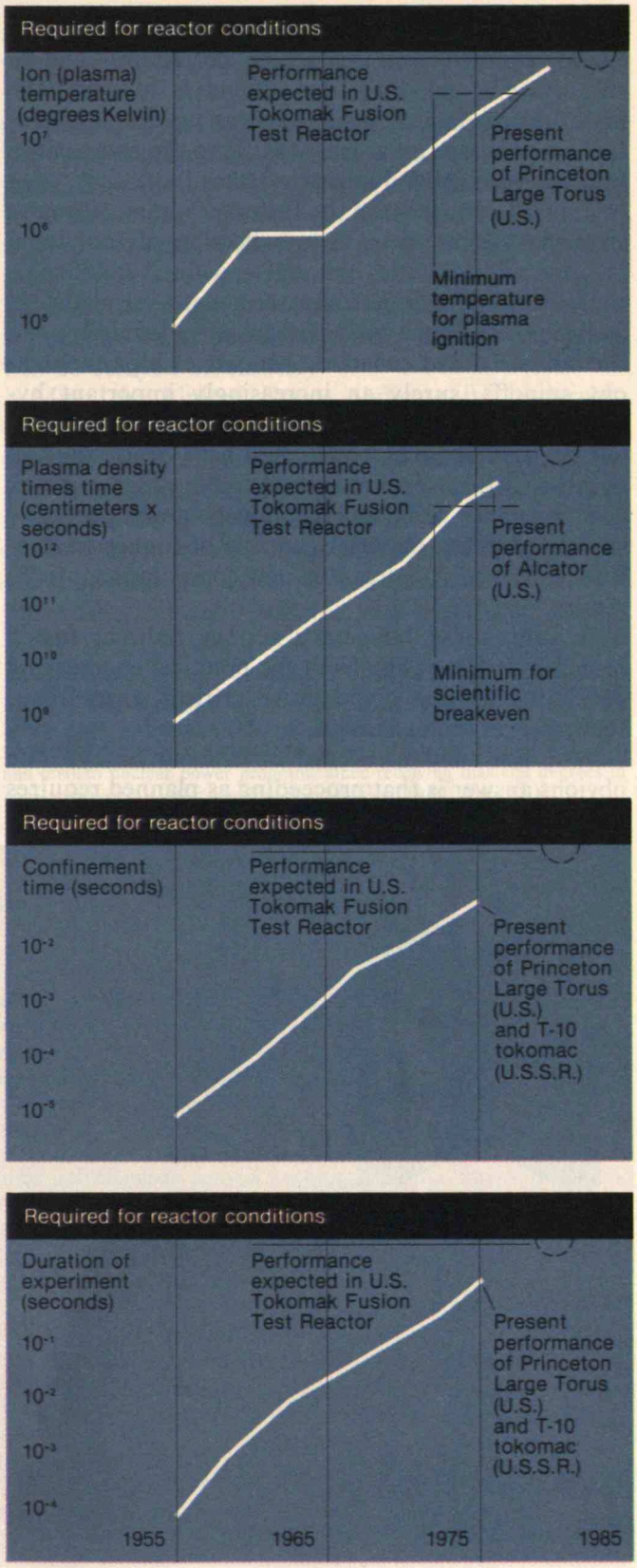
posals in June 1981 continued to embrace the goal of determining "the engineering feasibility of fusion energy during the next decade." But it was understood that while DOE would do engineering work, it was "not prepared to commit to the construction of a Fusion Engineering Device at this time." Accordingly, an 1982-83 budget of $557 million, about 10 percent above the 1982 budget, was proposed—the minimum required to hold to the basic strategy of the Magnetic Fusion Energy Engineering Act, although at a much reduced pace. The large increases in expenses visualized by the act were delayed beyond FY 1985. As the program director, I believed that this proposed 1983 program balanced the need to reduce expenditures with the strong program recommendations made by the review panels and enacted by Congress.

Now, however, with no formal hearings between the Department of Energy and the Office of Management and Budget, the 1983 budget has been presented to Congress with a total of $444 million for the fusion program. This is 25 percent less than the 1977 budget in real terms.

That amount allows for continuation of present laboratory activities, including the tokomak at Princeton. Indeed, most existing experimental efforts and many activities in the plasma physics program may be overfunded. But the $444 million does not provide for the broadening of activities recommended by the Foster committee nor the engineering initiatives recommended by the Buchsbaum panel and authorized by Congress. The 1983 budget provides only sufficient funds to keep a small design team working on the Elmo Bumpy Torus project; it provides no funds for the Advanced Tokamak Facility. It puts the Fusion Materials Irradiaton Facility "on the shelf," although over $60 million has already been spent for its design and development, and there are no funds to actively plan for the establishment of a Center for Fusion Engineering or a Fusion Engineering Device.

Finally and most important, the 1983 budget removes $25 million from the funding profile for the major mirror machine. If similar amounts are removed over the next two years as well, as implied by OMB actions, the mirror machine will be delayed by almost three years.

Two fundamental program decisions are implied in these changes. The first is to forego, for an undetermined but extended period, the strategy and schedule recommended by the Buchsbaum panel and incorporated in the Magnetic Fusion Energy Engineering



Recent budgetary decisions leave the fusion program without a strategic backbone.

Act of 1980. (Senior officals in the Department of Energy characterized this act as "permissive" and "a silly piece of paper.") The second is to delay the major mirror facility by up to three years and, therefore, to postpone by at least that long the comparison between toroidal and mirror systems.

Those decisions leave the fusion program without a strategic backbone—it is a collection of individual projects and activities without a defined mission or timetable. The plan to increase industry involvement in fusion development is postponed indefinitely, and the industrial and economic benefits of high-technology spinoffs, surely an increasingly important by-product of an accelerated fusion technology program, will be lost. These spinoffs could have been expected in areas such as vacuum tubes handling higher power and frequency than any previously developed, new superconducting materials, metals of higher irradiation resistance, robotics, and new computational techniques.

In sum, these budgetary actions redirect fusion research enitrely away from the practical engineering developments that could prove critical when fossil-fuel reserves are exhausted.

Why this sudden reversal in national policy? The obvious answer is that proceeding as planned requires a mortgage on the future at a time when the administration's overriding objective is to reduce such commitments. But there are gross inconsistencies between this thrust and the administration's stated energy policies. The National Energy Plan as forwarded to Congress by President Reagan says: "There is an appropriate federal role in certain long-term research. . . . [to bring] promising technological innovations to the point where private enterprise can reasonably assess their risks. . . The federal government recognizes a direct responsibility to demonstrate the scientific and engineering feasibility of fusion."

The administration's recommendations for other research programs in the Department of Energy (high-energy physics, basic energy sciences, and nuclear physics) generally were consistent with this policy statement. Only the technology programs—solar, synthetic fuels, fusion, and others—have been grossly weakened.

These budget reductions would be more readily understandable if the magnetic fusion program were failing, but the last several years have seen rich experimental and theoretical advance, with more promise for the achievement of practical fusion energy than ever before. These advances represent the start of an invaluable return on the investment the United States



Synthetic Fuels Through Fusion

Of all the fossil fuels, petroleum and natural gas are most in demand and most limited in supply. Substitutes for them will have to be found if we are to avoid future worldwide institutional and social disruptions early in the next century, perhaps sooner. Since many years are required to develop and implement major new technologies, serious studies of all potential alternatives for producing substitute forms of liquid and gaseous fuels must be undertaken now.

As I point out in the accompanying article, fusion is perhaps unique as a potentially inexhaustible major energy source. Its fuel is deuterium and lithium—the former available in seawater, the latter in widespread granite and brine deposits. Two reaction paths are followed in a fusion reactor. The deuterium-tritium reaction produces a helium atom and a highly energetic neutron. The deuterium-deuterium reaction produces either a helium nucleus and a moderate-energy neutron or a tritium atom and a proton. Some or all of the tritium then reacts with deuterium to produce a substantial number of the high-energy neutrons. These high-energy neutrons, carrying 80 percent of the energy from the fusion reaction, are highly penetrating, and will be captured by an absorbing blanket surrounding the reacting plasma chamber at some distance from the plasma.

This means that fusion reactors will have a unique characteristic—they will deliver their principal reaction energy at a distance from the reacting plasma, and this will make it possible to decouple the energy production and conversion systems. The blanket can be designed with operating characteristics essentially independent of the plasma and the requirements for its confinement and reaction. Thus, a blanket design could be developed that focuses almost exclusively on the special requirements of synthetic fuel production.

The key to the production of synthetic fuels is hydrogen; it is the essential ingredient that must be added to coal in converting it to liquid or gaseous synthetic fuel. Two interrelated processes would use the high-temperature heat

The day when fusion can make a significant contribution to world energy resources will be delayed indefinitely.

has made since 1973. A doubling of the present fusion budget from $400 million to about $800 million annually over a five-to-seven year period seems a modest investment considering past progress and the historic implications of fusion.

Delaying the Fusion Era

What are the consequences of this decision to turn away from a comprehensive program for the development of fusion as a practical energy resource?

☐ Strong U.S. leadership in the world's fusion program will be seriously weakened. The U.S. program, although only one-third of the world effort, exerts significant leverage on the remaining two-thirds. The effectiveness and confidence with which the United States has carried out its program since 1973 has stimulated fusion research everywhere, especially in Japan. With the possible exception of the Japanese, world programs will slow down in response.

☐ Divisive forces will surface within the U.S. program: one confinement concept versus another, one laboratory versus another, science versus engineering, industry versus national laboratories, national versus international objectives. In a time of consensus, competition is a source of strength. But in a time of restricted funding, it may become a point of controversy.

☐ With their strategic plan abandoned and additional budget cuts, researchers will be hard pressed to maintain morale and progress even toward reduced goals. The diminished short-term industrial payoffs from fusion development will likely lead to additional attempts to restrict the fusion program's objectives to science-oriented activities.

☐ Most important, the day when fusion can make a significant contribution to world energy resources will be delayed indefinitely.

Must the United States abdicate its leadership role? Must we fail to aggressively pursue the development of the world's last energy resource because our social and political systems lack the will and vitality to accept such a challenge? If we do not now proceed deliberately and vigorously with the development of the engineering side of fusion, the future will *look* different within 10 years and will *be* different within 25.

Edwin E. Kintner resigned early this year after five years as director of the Department of Energy's Office of Fusion Energy in protest over the programatic changes described herein. He has been associated with navy and civilian nuclear power programs since receiving master's degrees in naval engineering (1946) and nuclear physics (1950) from M.I.T.

from a fusion reactor to produce hydrogen by dissociating the hydrogen and oxygen atoms in water. These processes include thermochemical cycles, in which the energy required to break the chemical bond in the water molecule is supplied directly as heat from the reactor; and high-temperature electrolysis, in which electrical energy is added to the thermal energy needed to dissociate the hydrogen and oxygen.

A study at Brookhaven National Laboratory of a high-temperature electrolysis plant, driven by a tokamak fusion power reactor with a blanket at temperatures above 1000°C, suggests that production of approximately 1,000 metric tons of hydrogen per day is possible. That amount is equivalent to 20,000 barrels of oil if burned directly as fuel, and 40,000 barrels if used to convert coal into synthetic oil. At the same time the reactor would breed tritium in a lithium blanket to sustain operation of the fusion reaction itself.

The overall efficiency of the process, in terms of the energy gained from the fusion reaction compared with the chemical energy of the hydrogen product, is estimated at 50 percent. Conventional electrolysis using fusion-generated electricity could readily be used to decompose water, but this system would be far less efficient because of the limitations inherent in the production of electricity by low-temperature electrolysis.

In addition to providing an efficient source of hydrogen, fusion could also provide the substantial thermal energy required with the hydrogen for converting coal to synthetic liquid or gaseous fuels. With fusion supplying this conversion energy at higher temperatures than can be attained from other sources, the amount of synfuel produced from a given quantity of coal could be increased by a factor of two to three. At the same time, the environmental impacts (including release of carbon dioxide) of coal combustion would be reduced by a similar factor.

As I point out, research on fusion technology for practical use is well underway. We confidently expect the demonstration of energy break-even conditions in a fusion reaction between 1985 and 1990.

If fusion development is now pursued aggressively, a demonstration of technical feasibility, including substantial fusion power production in a high-temperature blanket, could occur in the early 1990s. Following further development and scale-up, the commercial feasibility of using high-temperature blankets for the production of synthetic fuels from fusion could be demonstrated early in the twenty-first century, just when supplies of liquid and gaseous fossil fuels are being seriously depleted.—*E.E.K.* ☐

SCIENCE/SCOPE

Transistorized series-resonant-inverter (SRI) technology has been advanced to a resonant operating frequency of 200 kHz in another step toward minimizing inverter size and weight for spaceborne power-conditioning applications. The new Hughes SRI design uses power field effect transistors, which permit higher switching speeds. The design allows use of smaller inductors and capacitors, resulting in faster response to transient load changes and input-voltage variation. The SRI could be used as a beam power supply of an auxiliary propulsion ion thruster, or as a power conditioner for a high-power traveling-wave tube.

A new software system can translate naval tactical messages into understandable form. Messages within a command, control, and communications (C^3) system are typically hard to understand because they are transmitted in telegram form and often omit subjects, direct objects, articles, prepositions, and punctuation. If grammatical errors creep in, messages can be rendered unintelligible. While conventional computer techniques can't make sense of a garbled message, a Hughes message understanding system called GRACIE can. Using artificial intelligence techniques, GRACIE understands general descriptions of flights of aircraft over ships, of attacks, and of encounters with hostile ships. It constructs grammatical sentences based on what it expects messages to be, referring when necessary to a "rule book" of examples. It can be adapted for other than naval use.

An advanced radio-telephone switching system for military shipboard communications eliminates the need for separate equipment for plain and secure voice channels. The Secure Voice Switch (SVS) system lets radio-telephone users select either secure or plain channels. It uses a microprocessor-controlled single audio switch. Large-scale integrated (LSI) circuits designed and manufactured by Hughes prevent crosstalk between the two kinds of channels. Hughes is producing the SVS system for the U.S. Navy for use aboard a wide range of ships, from frigates to aircraft carriers. The first production unit is being installed aboard the cruiser USS Long Beach.

A new family of compact helium-neon laser systems, with laser head and power supply contained in a single housing, has been introduced. The Hughes 3300 series lasers are available in six power ratings, from 0.4 to 6 milliwatts output power. They are suited for laboratory, research, industrial, and OEM uses -- including holography, data recording, spectroscopy, light-scattering, velocimetry, non-destructive testing, interferometry, and alignment systems.

Hughes is seeking engineers to develop advanced systems and components for many different weather and communications satellites, plus the Galileo Jupiter Probe. Immediate openings exist in applications software development, data processing, digital subsystems test, microwave/RF circuit design, power supply design, digital communications, signal processing, spacecraft antenna design, system integration test and evaluation, and TELCO interconnection. Send your resume to Tom W. Royston, Hughes Space & Communications Group, Dept. SE, Bldg. S/41, M.S. A300, P.O. Box 92191, Los Angeles, CA 90009. Equal opportunity employer.

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TRENDS

Stirring the Chemical Arms Race

Although officially banned from first use in battle, chemical weapons (CW) and defenses against them are winning significant funding. Last year the U.S. spent $262 million on chemical and biological warfare (CBW) weapons and defenses; this year's budget is $455 million, and the Reagan administration recently announced a tentative 1984 CBW budget of $1.4 billion.

The escalating budget seems to defy the Geneva Protocol of 1925 (ratified by the U.S. in 1975) that forbids the use of CW agents. However, the agreement fails to forbid the *possession* of such armaments.

Despite the protocol's presumed intention of ridding the world of these heinous weapons and President Nixon's reinforcement of that goal—including a pledge that the nation would not use chemical or biological weapons in a first strike—today the United States as well as France and the Soviet Union have stockpiles, along with the military capability to use and defend against them. According to unclassified estimates, the U.S. presently stockpiles "many hundreds of thousands" of CW artillery shells, Matthew Meselson, professor of biochemistry at Harvard University, told the AAAS annual meeting in January. He assumes that Soviet CW capability is "formidable," emphasizing that he reaches this conclusion "on the basis of prudence, not definite evidence."

Alarmingly, reports of their use persist from Afghanistan and southeast Asia, but these reports are controversial and even contradictory. For example, Arthur H. Westing, dean of natural science at Hampshire College, first told the AAAS that "there is very strong evidence that chemical agents (including "Yellow Rain" mycotoxin) are being used." Yet later he said that "there are places where the natural levels of these fungal toxins are in fact higher than that [noted by the U.S. State Department]. . . . One could come a lot closer to providing suggestive evidence than has been done so far."

Amidst the controversy and despite the administration's increasing CBW budget, Robert Mikulak, physical science officer of the U.S. Arms Control and Disarmament Agency, told the AAAS that his agency believes such weapons "must be declared and destroyed."

It is at best a confusing situation, not an unexpected result of Dean Westing's char-



TIM BARKER

acterization of chemical-weapons technology as an "extraordinarily secretive thing—more secretive than even other military matters are." The confusion has an appropriate analogue in the clandestine toxicity of the colorless, odorless nerve-gas agents called "GB" and "VX"—the state-of-the-art weapons in today's chemical arsenal.

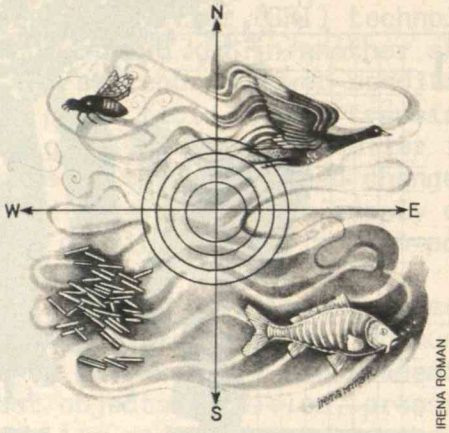
The current direction in building up chemical artillery weapons is to produce "binary shells." According to Professor Meselson, a binary device is "a little chemical factory" with "very low toxic hazard" until it is fired. When a binary artillery shell is fired, two cannisters of chemicals burst within and their contents mix to produce nerve gas. (A similar arrangement would be possible in missiles.) Then a detonator and "burster" explode under contact and release the deadly contents.

But some shortcomings could compromise the binary's effectiveness in battlefield situations. For one thing, it is a complex munition that must be painstakingly assembled (roughly a two-minute procedure) before use, sometimes during the height of battle. "No military man would prefer to have to go through all that," speculated Professor Meselson.

There's no controversy about the relative killing power of a chemical round versus a modern high-explosive round of artillery. "You can protect soldiers . . . against chemicals, but . . . you cannot protect them against the fragmentation effects of high explosives nearly so effectively," said Professor Meselson. However, unprotected civilian populations would be at extreme risk from chemical agents.

If the binary artillery shell has such limited tactical value on the battlefield, why has it been targeted for substantial funding? Professor Meselson cited claims that U.S. production of the binary could be useful in negotiations with the Soviet Union on chemical disarmament. But to begin production now, when the Reagan administration has cut off negotiations with the Russians and has given no hint that it intends to resume them, would be to "simply throw away a bargaining chip."

Dean Westing told the press corps that "to put the kindest light on these actions (production of the binary), one could say that the U.S. is going at this half-cocked and unprepared. Putting a less kindly light on it, one could say that the U.S. is stirring up things, trying to embarrass and annoy the Soviet Union . . . to provide an excuse for reopening the whole question of legitimizing chemical weapons in the U.S. arsenal."—*L.A.P.* □



IRENA ROMAN

Animal Magnetism

Birds, bees, fish, bacteria, now algae—all navigate through their varied environments at least in part by reading the earth's magnetic field. Many—perhaps all—have built-in magnetic detectors in the form of small accumulations of magnetite (Fe_3O_4, a dark mineral with magnetic properties) surrounded by arrays of nerve cells.

But much of the evidence for biomagnetic navigation is circumstantial, Professor Joseph L. Kirschvink of the California Institute of Technology admitted to the American Association for the Advancement of Science early this year; and thereby hangs a cloud of uncertainty over the entire field.

Magnetite is widely distributed throughout living things, says Professor Kirschvink. Many higher animals have tiny magnetite "capsules" in their sinuses. For example, tuna have a small capsule of magnetite in their snouts, assumed to account for the fact that the fish can be conditioned to associate a reward or punishment with a change in the magnetic field through which they swim.

Richard B. Frankel and colleagues at the M.I.T. Francis Bitter National Magnet Laboratory, who showed some years ago that aquatic bacteria have internal "magnetic compasses" for magnetic navigation, have found similar capabilities in certain green algae. Algae found in sediments near Rio de Janeiro migrate downward into the sediments along magnetic field lines, Dr. Frankel told the AAAS. And when the researchers alter the field lines, the migrational movement of the algae changes accordingly.

Most birds seem to use the earth's lines of magnetism for navigation only when celestial landmarks—sun and stars—are not visible. Studying the behavior of homing pigeons, Professor Charles Walcott of Cornell's Laboratory of Ornithology concludes that the birds can detect magnetic field lines as weak as one-five-hundredth of those of the earth—"an extraordinary sensitivity," he says, and difficult to comprehend. He confessed his frustration as his homing pigeons return to their roosts from journeys through rain, sleet, snow, and even magnetic anomalies: he's tempted to grab one by the scruff of the neck and demand to know its secret: "How *do* you find your way?"—*J.M.* □

Silicon in a Bind

It has long been considered impossible to make. Its discoverers say that although predicting specific technological applications is too early, "new insights into the nature of chemical bonds and new materials with unexpected properties will likely result."

The creation is a stable compound containing two silicon atoms connected by a double bond. (In a "double bond," the atoms share four electrons; in a single bond, they share only two.) Called tetramesityldisilene, it was synthesized in late 1981 by Mark Fink, a chemistry graduate student at the University of Wisconsin, along with his advisor, Robert West, and Josef Michl of the University of Utah.

Tetramesityldisilene is produced photochemically: complex silicon-containing molecules are bathed in ultraviolet light to induce the critical reaction step. The new compound has two groups, called mesityls, attached to each silicon atom.

The bulky size of the attached mesityls, along with the low temperature during synthesis, make the critical difference between this successful experiment and earlier attempts, Fink explains. During most early failures, the silicon atoms briefly formed a double bond, but then many atoms joined together, or polymerized, and the double bonds broke. Attachment of the two relatively large mesityls to each silicon atom prevents polymerization from rushing along and renders the double-bonded compound stable.

All known life is based on carbon chem-

istry, which depends on the ability of carbon atoms to form chains, rings, and especially multiple bonds. Silicon, located just below carbon in the periodic table of the elements, closely resembles carbon and also forms chains and rings. Indeed, it is so much like carbon that the past decade has seen the development of a growing family of silicon-based plastics, lubricants, and industrial compounds in which silicon replaces carbon. But silicon's usefulness as a molecular building block—the richness of its chemistry—has been limited because chemists have been unable to make compounds with double bonds between silicon atoms, despite numerous efforts to synthesize them since early this century.

"We feel the door is open to a major area of chemistry that may produce many compounds with technologically interesting properties," says graduate student Fink. "This particular new compound hasn't shown any commercially exciting properties yet. But remember, for a long time scientists considered the possibility of *any* such compounds as highly unlikely."

The new compound has one unusual trait, though: it changes color as its temperature changes. At room temperature it is a yellow powder that can be stored indefinitely. When heated, it turns dark yellow, then orange, and finally deep red (it melts at 176 degrees centigrade but does not decompose). The entire "thermochromic" process is reversible. "As a quick thought about applications, such color changes might be useful in temperature-sensing devices," Fink notes. "But we hope continued research will yield compounds with even more interesting properties."

The chemists predict that numerous compounds with silicon-silicon double bonds will be synthesized. So, too, will stable compounds containing silicon multiply bonded with other atoms, such as nitrogen or oxygen, which have long been sought. Moreover, the chemists are expanding their work to include the next element down in the periodic table, germanium, which also resists forming double bonds.

"We want to learn how to synthesize some of these other compounds to see what chemical properties they will have in general, and to see how those properties might be manipulated by varying the chemical groups attached to the atoms," Fink says.

Exotic creatures based on silicon instead of carbon may still be fodder for science fiction. But silicon chemistry has taken a significant stride, and the technological implications are still being imagined.—*T.B.* □

Software: Growing Out of Adolescence?

A computer is no better than the instructions it follows. Its effectiveness thus depends on the quality of the "software" that guides it through its paces.

The price of computer hardware is dropping dramatically—but not the cost of software, which now accounts for 70 to 80 percent of the cost of large information processing systems. Software development constitutes at least half of all research at Bell Telephone Laboratories today, says Edwin A. Irland, Bell Labs' quality-control director. The complexity of programming is greater than ever before—and still increasing.

Yet too much of the software scene remains like an "amateur hour," says William M. McKeeman, who heads the information technology faculty at the Wang Institute just outside Boston, and it's not clear what good programmers have that the rest don't. Most programmers are self-taught; no colleges have curricula specifically on software. Only now are the beginnings of a discipline emerging, Dr. McKeeman told the American Association for the Advancment of Science in Washington.

Here are some principles for developing quality software that have grown out of Bell Labs' experience:

□ Good software must be based on good logic. Fundamental conceptual errors can proliferate into troubles that are literally impossible to find.

□ The earlier that bugs can be found, the better.

□ Software of the complexity in use today cannot be completely "debugged," and there's no point in trying. If 90 percent of the bugs can be eliminated, down-time can be limited to a few hours a year—adequate for almost all applications. For other uses, higher quality—even less downtime a year—may be needed, but costs go up accordingly.

□ The most important stage in software design is that of establishing its requirements. For example, the Apollo lander was to have been guided to its lunar base by computer, but at the last minute the computer couldn't do the job and the astronauts had to take over. The computer was simply being fed more radar data from the lunar surface than it could process—a failure in the original statement of program requirements.

But software *will* grow better, said Mr. Irland, and the same kind of quality assurance so successful in other engineering fields will begin to work in this one. Some notions of the difference between good and bad design practices are now emerging, and there are at least some guidelines (for example, the number of "bugs" per 1,000 words of a program), if not yet an empirical measure, for software quality. If measurement becomes possible, standards will not be far behind.—*J.M.* □

Print Media Not Terminal

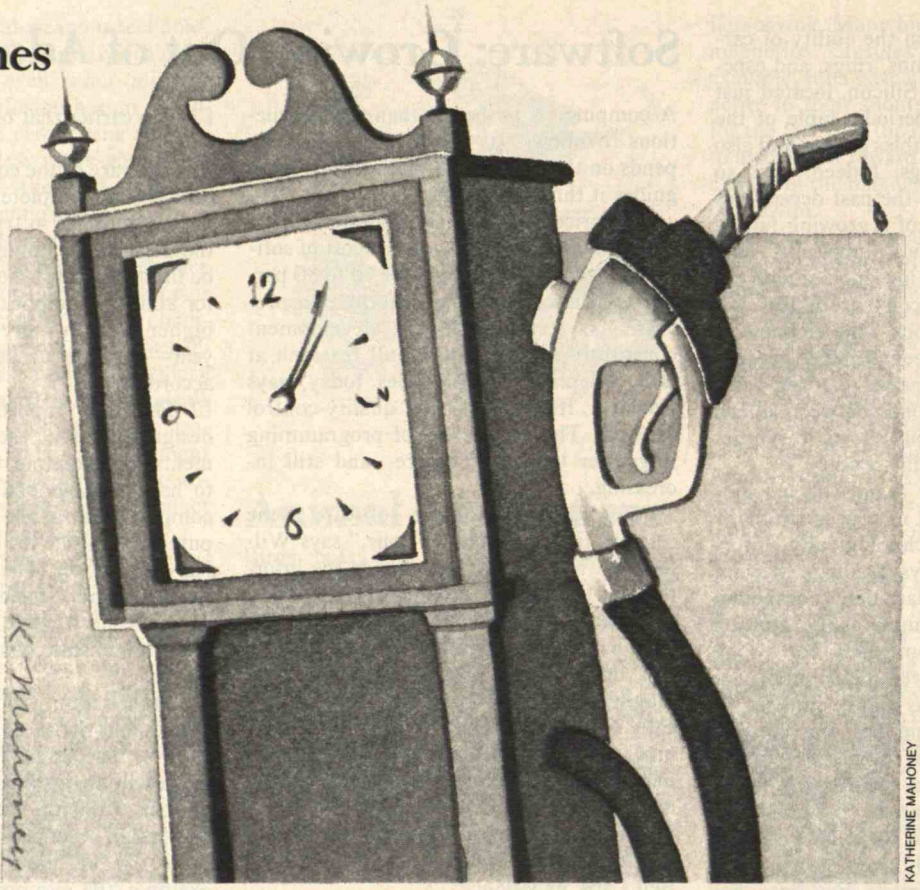
Reports of the impending death of newspapers and magazines—victims of cable television, home computers, and electronic mail—are greatly exaggerated, says Professor W. Russell Neuman of M.I.T.'s Research Program on Communications Policy.

It's true that the typical home of the 1990s will have a communications center served by two-way coaxial cable and one-way satellite broadcast links. But there will also be a daily newspaper on the front steps every morning, evidence of "the character of human behavior."

We like our news that way, says Professor Neuman. We like to have old newspapers around the house for wrapping up things as well as for casual reading, and we like to clip out things for later use. Indeed, we are very much addicted to things as they are, says Professor Neuman in describing this domestic scene in the electronic age of the 1990s:

"As evening falls, one member of the household is cleaning up in the kitchen and listening to broadcast radio. Grandpa has fallen asleep with his newspaper in the living room. Another family member is upstairs watching a game show on broadcast television. The two-way terminal in the living room has been turned on by the children and the word 'ready' can be seen at the top of the video screen. But the terminal is unattended. They changed their minds and went out to play."—*J.M.* □

Tense Times When Oil Runs Out



Imagine that the Strait of Hormuz between the Persian Gulf and the Indian Ocean is suddenly closed, depriving the U.S. of 5 million barrels a day of crude oil—over 30 percent of its current consumption. Or that Saudi Arabian oil production collapsed, and with it 3.3 million barrels a day of crude slated for shipment to the U.S.—about 60 percent of current imports.

How should our oil-dependent economy prepare for such violence? And if it comes, what should we do to survive a shock of such proportions?

There is general agreement among Cambridge analysts on four answers to those questions:

☐ We must have a strategic petroleum reserve—the larger the better.

☐ We must capitalize on the free market's power to equate supply and demand through rising prices.

☐ We must be prepared to soften the hardships that will result from skyrocketing fuel prices.

☐ We must use all the resources of economic policymaking to stem the tide of "stagflation" that will inevitably accompany a sudden, sharp decrease in energy supplies and the resulting increase in prices.

The U.S. has a program for storing up to 538 million barrels of oil by 1986. The drawdown rate could be as high as 3.5 million barrels a day, and the facilities might be stretched to contain 1 billion barrels. So far this petroleum reserve contains about 300 million barrels, but its growth has been slow and painful. Saving oil in today's market has been "very difficult," says Jonathan Berman of Harvard's Energy and Environmental Policy Center.

Given a totally free market, a disruption causing a shortfall of 15 to 25 percent of normal gasoline supplies might take the price of gasoline to perhaps $5 a gallon, according to Thomas F. Humphrey of the M.I.T. Center for Transportation Studies, who has just completed a contingency planning guidebook for public officials. Knut A. Mork of the University of Arizona, in an analysis made while he was at the M.I.T. Energy Laboratory, is only slightly more optimistic: his model shows that an oil supply disruption of 10 million barrels a day could lead to a 35 percent increase in the price of oil in its first year, a further 17 percent increase in the second year, and an average 5 percent hike in the third year. (That alone would generate a 5.7 percent ante on whatever inflation rate was already in prospect for the year of the disruption—"disturbingly large," says Dr. Mork.)

The advent of uncontrolled oil prices makes driving bans and odd-even-day fuel purchase plans irrelevant; price will act to clear the market and eliminate the lines we remember from the 1970s. But governments should be prepared to institute some coping measures, says Mr. Humphrey: ride-sharing; increased mass-transit services, including the use of charter and school bus fleets, taxis, and perhaps even rental vehicles; alternative work schedules to reduce peak travel demands; and fuel stockpiling to cover essential needs, including those of public transit.

Rationing is not on Mr. Humphrey's list; indeed, no one likes it very well. It would be very costly—$525 million in startup costs, and as much as $1.9 billion a year to run it—the equivalent of adding several cents per gallon to the price of gasoline. This is probably more than the economic costs of queuing or spot shortages that rationing might avert. And rationing would have to be accompanied by an allocation program to make sure that essential needs such as public health, safety, and transportation were met.

Having studied these alternatives and the history of our responses to the oil shortages of the 1970s, Philip K. Verlager, Jr., of the Harvard Energy and Environmental Policy Center offers several suggestions:

☐ Avoid federal allocation programs and intervention to divert supplies. Such programs cause cautious suppliers to hold back stocks just when they are most needed.

☐ Never authorize unlimited access to the market by any segment. Such allocations "probably promote dishonesty and clearly force suppliers to increase precautionary stocks."

☐ Avoid federal intervention to assure supplies for critical economic sectors. Such directives are a "veil" behind which suppliers can hide. A better course is to rely on "moral suasion" to assure needed supplies.

☐ Recognize that consumer prices will rise, even if refinery prices are controlled, and that the increases may well be higher with controls than without.

☐ Encourage suppliers to help one another, in the tradition of bankers who have discovered that the failure of one bank can

increase the vulnerability of others.

The broad economic effects of any future oil-supply disruption as great as 10 million barrels a day would be stunning—a total economic cost of up to $512 billion, according to Dr. Mork's models. Gross national product would be drawn down by over $120 billion in the first year, and unemployment would go up by 3 percent.

To stabilize an economy in such a plight, Dr. Mork offers an "ideal policy tool": cut the employer's share of the Social Security tax, with the reduced labor costs to be passed through to consumers in the form of lower prices and the cut to be financed with general revenues. Such a cut would reduce real wage costs to employers without a corresponding decrease in workers' take-home pay. It would thus decrease unemployment, stimulate investment, and wipe away energy-induced inflation.

But because the lower prices might not be realized, Dr. Mork has a supplementary proposal: a temporary increase in the investment tax credit—an attack on the crucial problem of declining investment activity following a disruption. A wrong move would be to tighten money supply in an effort to stem inflation, which in the short run would increase unemployment more than decrease inflation. Also, increasing government spending to stimulate the economy would discourage private investment and be very expensive. Dr. Mork says $90 billion of such spending would be needed to stabilize employment during a 10-million-barrel-a-day oil disruption.

But whatever strategies the nation pursues to deal with a major disruption, it's clear that Dr. Verlager's final piece of advice is very much on target: "Be prepared for tense times."—*J.M.* ☐

To Understand Oil, Watch the Market

Sketching "what-if" scenarios about the effect on the United States of an oil shortfall caused by a Middle East revolution or a Gulf of Hormuz blockade is deceptively simplistic, says Thomas L. Neff of the M.I.T. Energy Laboratory. We forget that world oil markets are dynamic—that what happened in 1973 would not happen in 1985. By watching the market and reading its signs, says Dr. Neff, we might gain significant clout over the impact of a future event that imperils world oil supplies.

For example, Dr. Neff told a conference on contingency planning at Georgetown University late last year that today's buyer's market in oil—with plentiful supplies and lower prices—seems at first to be a boon for consumers. But that may be illusory in the slightly longer run. Three reasons:

☐ What is good for consumers is bad for producers. With OPEC sales and income down, the expectations of many of its peoples are frustrated and the chance of political instability is increased. Robert S. Pindyck of the Sloan School of Management sees Saudi Arabia as "an extremely unstable entity . . . a land where the fantasies of people who write mystery novels are acted out." Would higher prices now buy what seems to be almost beyond price: political stability in the Middle East?

☐ Plentiful supplies lull consumers into overconfidence: we worry too little about how to deal with the emergency that we all hope will never come, says Dr. Neff. A modest example of how this works: with its research completed but before the job of issuing recommendations to state and local governments had begun, funds were withdrawn from an M.I.T. project on contingency planning for transportation in a time of oil shortage. Its data are now gathering dust in a storeroom.

☐ Responding to falling profits, producing nations are assuming a greater role in world crude trade and making inroads into refining and even marketing. And reacting to today's profit squeeze, domestic oil companies are consolidating facilities and reducing stocks. These changes make sense in a time of surplus, but in a time of crisis they could make market readjustments more difficult than a decade ago.

We should worry about such trends more than we do, says Dr. Neff, watching the market for its signals on how the future will be different from the past. "If and when the tide goes out," he told his Georgetown University audience, "consumers may have to negotiate some unexpected shoals."—*J.M.* ☐



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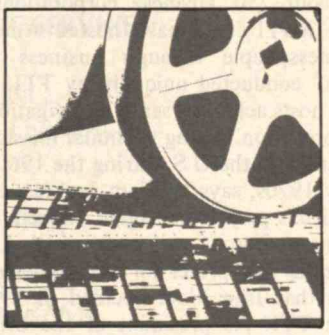
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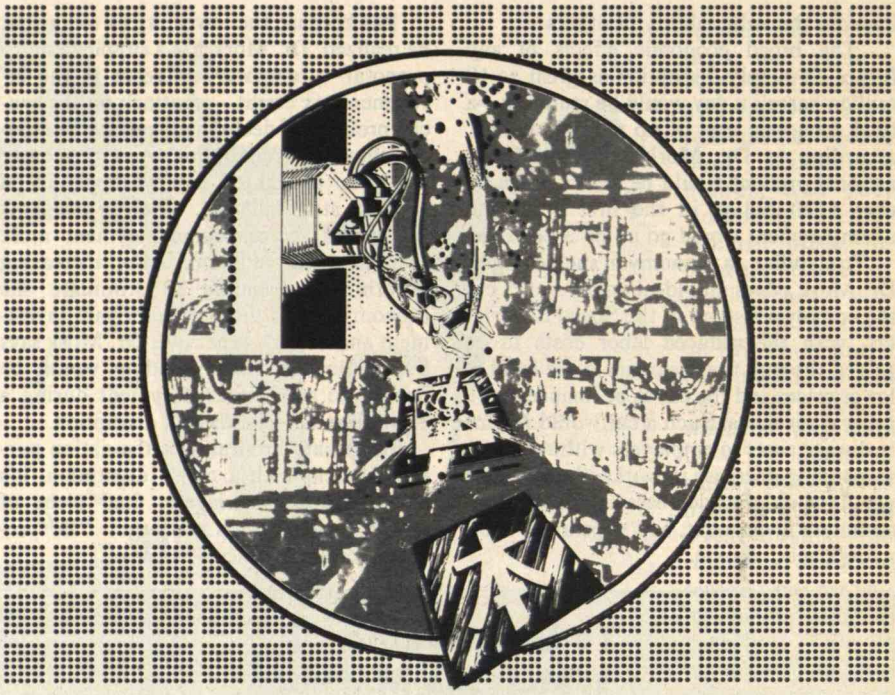


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All Aboard the Japan Transfer



TIM BARKER

Studying business management firsthand in Japan has become a common, even fashionable, way for U.S. business executives to spend a few weeks abroad. In the process they learn how Japanese companies churn out high-quality export goods (until a year ago, the companies had to be licensed for export by the Japanese Ministry of International Trade and Industry, or MITI). And for the past few years management journals have described at length these travelers' discoveries: the paternal Japanese staffing system that aims to retain—and promote—workers despite changing business conditions, employees' fierce company loyalty, and the innovative organization of workers into tightly knit "quality-control" circles.

But U.S. executives are now visiting Japan to gain basic technological insights as well. At the same time, "Americans are beginning to pull back on the information they are willing to share with Japan," says Nancy Dyer, an executive with Technology Transfer Institute (TTI), a management consulting firm based in New York and Tokyo. These changes could be signs that U.S. business leaders realize they may be losing their competitive edge in high-technology fields, she says.

About 250 Japanese corporations and even MITI itself have hosted American businesspeople through business "missions" conducted uniquely by TTI. Japanese hosts act on a "sense of obligation and reciprocation" owing to similar missions by Japanese to the U.S. during the 1960s and early 1970s, says William Jenkins, one of the firm's project managers. Indeed, it was during numerous such tours to the United States as interpreter for MITI representatives that Isao Idota decided in 1969 to form TTI. As president of the firm, he describes his long-range goal as encouraging the "equal exchange of information among all people." About 1,000 international forums, seminars, and study missions are evidence of his efforts.

However, the hard realities of competitive business preclude the sharing of sensitive proprietary information by either side. And until recently, neither nation's business tourists expected or requested that—they simply visited to "size each other up and to debunk myths," says Jenkins. True, an occasional joint venture may have been struck and other business links forged, but the trips were generally organized around "soft" managerial topics, diplomatically sidestepping strategic "hard-technology" secrets.

The 1982 tour calender of TTI indicates a radical change. Cutting-edge technology now vies for top billing with quality-control circles and productivity concerns. American visitors sampled the following exotic fare (at TTI's price of about $5,000 per participant and $4,000 per spouse) earlier this year: "Laser Technology in Japan," "Flue-Gas Cleaning Technology in Japan," and "Japanese Technology in Electronic Weighing." Future offerings include "Welding Technology in Japan," "Quality Control for Microprocessors," and "Robotics."

"This is the right time for us to give something back to the American people," says Idota. Considering the worsening profits and productivity rates of several key U.S. industries, his sense of timing for technology transfer is right on track.—*L.A.P.* □

Winning the "Quality Revolution"

The seeds of the U.S. productivity problem were sowed when professional managers displaced engineers from the presidents' offices and board rooms of U.S. technological industry following World War II.

Management education today emphasizes general concepts and techniques—such as control systems, financial analysis, decision techniques, and strategy formulation—rather than the specifics of individual markets and technologies, says Professor Robert H. Hayes of the Harvard Business School. The objective is to develop highly mobile "professional managers," but one consequence is that fewer and fewer people with technological expertise occupy the top jobs in American manufacturing companies. As a result, these companies tend to concentrate on financial results, seeking to keep stockholders happy and company assets secure by maximizing short-term return on investment and minimizing risk.

In contrast, emphasis on technical excellence and product quality characterize our most aggressive German and Japanese competitors. They come to this emphasis from the pressures of the technical marketplace: "Poor quality is [measured by] the losses a product imparts to society from the time the product is shipped," Genichi Taguchi of the Japanese Academy of Quality told the American Association for the Advancement of Science. The timing of this emphasis on quality among our com-

petitors is impeccable: worldwide inflation has stimulated a new interest in product quality in every marketplace, says Armand V. Feigenbaum of General Systems Co. Buyers now rate quality as high or higher than price in making purchase decisions—there is "a quality revolution going on in the international marketplace today," Dr. Feigenbaum told the AAAS.

How does the modern American management ethic put us so much on the defensive in this marketplace? It insists that managers must manage and workers must work—"one gives orders and the other fulfills them," says Professor Hayes.This dogma leads to divided responsibility and conflict, the roots of low productivity and poor product quality.

"The adversary relationship between management and labor in the U.S. is what most astonishes Germans and Japanese about our industrial system," Professor Hayes told an M.I.T. seminar this winter. It is perhaps the most telling symptom of U.S. industrial ills.

Lots of the "excuses" for U.S. productivity and competition problems, and our perception of the sources of Japanese and German superiority, are more imaginary than real. A sampling from Professor Hayes includes the following:

☐ High taxes and excessive government regulation in the U.S.: Both business taxes and regulation are higher in Germany, where labor has a far larger hand in government ("an enormous legislated apparatus") than here. And "Japan, Inc." is a myth, he says: Japan is "one of the fiercest competitive environments in the world." A government bail-out of a Japanese Chrysler Corp. would be "unthinkable."

☐ Steeply rising energy costs: Energy consumption per unit of gross national product is lower in the U.S. than in Germany, and both Germany and Japan are almost wholly dependent on imported oil.

☐ Heavy reliance by our competitors on robotics and other modern manufacturing technologies: True, there are more robots now at work in Japan than in the U.S., and Japanese investments in plant and equipment are over twice those of the U.S. as a percent of GNP. But manufacturing companies in Japan and Germany strive to increase the capacity and efficiency of existing equipment, says Professor Hayes. Instead, U.S. managers tend to concentrate their investment on new machines, which are then integrated with the old ones. The result: a mixture of capabilities rather than a finely tuned system.

☐ Higher output per worker among our competitors: That may be true in a few manufacturing industries, but not in any foreign economy as a whole, said Edward F. Denison of the Department of Commerce Bureau of Economic Analysis.

☐ Far lower wages in other countries: Because of perversities in currency exchanges, it's hard to judge the purchasing power of dollars in comparison with marks or yen. But during the past decade, Japanese wages have risen to the point where (with important exceptions) they are comparable with those in the U.S. German wages are "the highest in the world," Professor Hayes said—20 percent to 30 percent more than those in the U.S. and Japan.

Perhaps the most powerful lesson for American management in the Japanese experience is Japan's reliance on "do it yourself," says Professor Hayes. Japanese firms train their own workers, build their own production equipment, and then make their own improvements. Engineers are closely involved with ongoing problems; their offices are usually adjacent to the factory floor. Workers even help design machines and describe products during sales calls. In contrast, says Professor Hayes, U.S. industry has "systematically isolated engineers in separate buildings," and U.S. firms are "almost wholly dependent on equipment suppliers" because they cannot build or even modify their equipment.

For much the same reasons, U.S. firms confront a critical shortage of trained workers. German firms put "enormous emphasis" on training, while most U.S. managers consider education and training public responsibilities. Thus, the U.S. will confront a shortage of 9,000 tool and die makers and perhaps 20,000 skilled machinists per year through 1985.

But the U.S. has some fundamental strengths in its battle with competitors: It has a high rate of investment in research and development. Moreover, the U.S. pioneered the ideals of quality and productivity, and Dr. Feigenbaum thinks they're coming into a renaissance. "The attitudes of quality-mindedness and productivity-mindedness have been underpinning American factories for a very long time."—*J.M.* ☐

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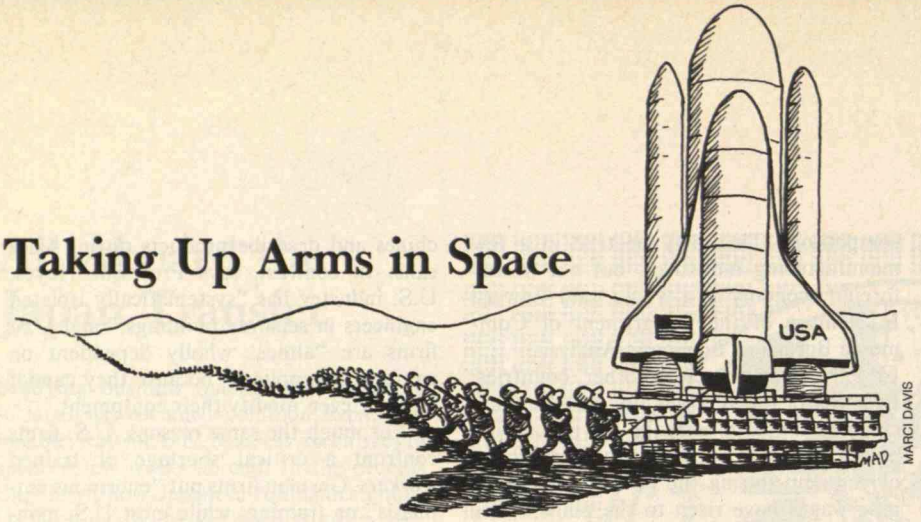
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Taking Up Arms in Space



MARCI DAVIS

Fifty years from now, hundreds of thousands of people will have gone into space and returned, says Hans M. Mark, deputy administrator of the National Aeronautics and Space Administration. But what will they have been doing out there?

Those from the United States, at least, will probably have been on military business. Looking back on the drama of the manned space program—including the heights and the tragedy of Apollo—it is clear that the nation's basic space priorities have changed. Some of the force for change was in Carter's Presidential Directive 37, issued in June 1978 shortly after the Soviet Union had demonstrated that it could destroy satellites in orbits as high as 1,000 miles. President Carter called for programs to enhance the survivability of our space systems, talks with the Soviets on limiting space weaponry, and, in the event of unproductive talks, development of a U.S. antisatellite capability.

In response, the U.S. military intensified its study of specific defensive strategies and weapons systems. These included the "miniature homing vehicle" or MHV (a two-stage rocket launched from an aircraft and guided to its orbiting target by heat sensors), the hardening of satellites against attack, the deployment of backup satellites in high "parking" orbits, and the development of laser battle stations.

The space shuttle is vital to the achievement of some of these goals, and it will likely eventually replace the expensive Titan III family of expendable launch vehicles. Indeed, from the beginning the space shuttle has been "largely a military project," Dr. Mark told a March colloquium at the Wheeler School in Providence, R.I.

It should therefore come as no surprise that the lion's share of the $6.6 billion that President Reagan has proposed for NASA's 1983 budget is earmarked for the shuttle program. Thus, the United States is unquestionably on its way to having a space transportation system. In June the *Columbia* will be joined by the *Challenger*, and later by the *Discovery*, *Atlantis*, and *Enterprise*. Each will perform six to eight missions per year over a 10-year life time.

Victor H. Reis, assistant director for national security in the Office of Science and Technology Policy, told the annual meeting of the American Association for the Advancement of Science that for now, the government should concentrate on getting the most out of the shuttle fleet: military uses, commercial applications (mostly privately developed), and space and atmospheric science experiments done in orbit.

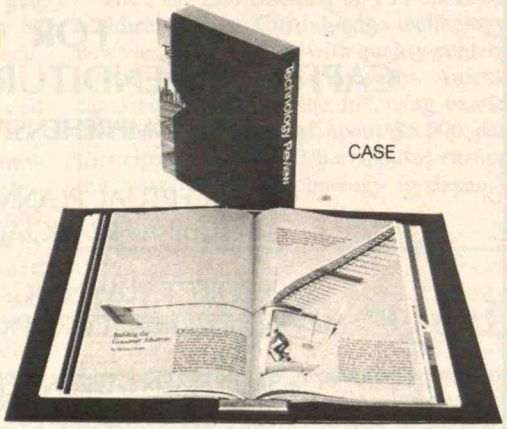
However, the foundation of NASA and the U.S. space program—the National Aeronautics and Space Act of 1958—makes no mention of military activities in space. Indeed, it assigns to the Department of Defense (DOD) "activities peculiar to or primarily associated with the development of weapon systems, military operations, or the defense of the United States." This prompts some critics to say that it is only a matter of time until the shuttle becomes a DOD responsibility and NASA's central role in the nation's peaceful space effort is reduced to that of temporary bus driver. NASA will also be custodian of the proposed space operations center, described by Dr. Mark as a "permanent presence in space."

Yet the Space Act mandates preservation of U.S. leadership in aeronautical and space science. John E. Naugle, former NASA chief scientist and now with Fairchild Industries in Germantown, Md., is concerned about the effect of the militarization of space on space science—and world peace. He reminded the AAAS that "the people who formulated the original

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space policy recognized the value of the message a successful, highly visible Apollo, Viking, or Skylab mission gave the world, one that a competing society could respond to without escalating the arms race."

However, the Reagan budget provides only bare-bones funding for space science next year: $92.6 million for the Jupiter-orbiting Galileo satellite program, $21 million for a joint sun-probe mission with several European nations, and lesser funding for a space telescope and maintenance of a Voyager tracking network for flybys of Uranus and Neptune. For the sixth straight year, there is no funding for new scientific endeavors in space.

The American Astronautical Society (AAS) says the Reagan budget for 1983 will "devastate" planetary research. It urges the restoration of at least $40 million "to maintain a minimal planetary effort" and cites a litany of imminent cutbacks:

☐ Much of the data gathered by the Voyagers will go unstudied.

☐ The Galileo mission will "lack scientific guidance."

☐ The Pioneer Venus Orbiter, which was to monitor Halley's comet in 1986 and study Venus until 1992, will be shut down prematurely.

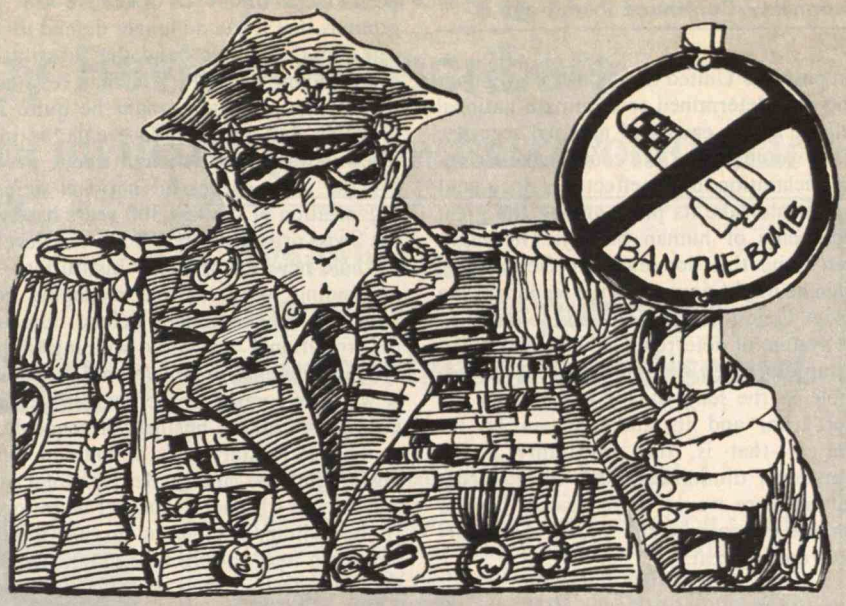
☐ *Pioneers 10* and *11*—"still returning data on the distant region where the solar system meets interstellar space"—will be turned off permanently.

☐ The Lunar Curatorial Facility in Houston, which houses the moon rocks, will be closed.

☐ The Infrared Telescope Facility, completed in 1979, will be closed.

David Morrison, past chairman of the AAS Division for Planetary Sciences, warns that "NASA officials may speak of 'mothballing facilities' or 'deferring programs,' but you can't mothball or defer the people whose special dedication and knowledge make our planetary program a reality."

"We have not had any national debate to conclude that our general welfare and security no longer require the United States to be a leader in space science and technology," Dr. Naugle told the AAAS. "We who are aware of the potential of space have two choices. We can let things continue to drift (toward militarization and away from scientific work) until a new *Sputnik* dramatically challenges our leadership and demonstrates that drastic action is required. Or we can honestly and systematically explain the situation to the public, who can then insist to the politicians and their budgeteers that they must set things right."—*L.A.P.* ☐



JON McINTOSH

War with Honor

"Well, boys, this is it," the B-52 captain in Dr. Strangelove *proudly announces. "Nuclear combat toe-to-toe with the Russkies." And back in the Pentagon War Room, a general pleads with the president for a full-scale nuclear follow-up, assuring him that "no more than 10 to 20 million killed, tops" will be suffered at home.*

A persistent image of military people is that they are trigger-happy, or at best indifferent, about actually using their arsenal of nuclear weapons. But Freeman Dyson, professor of physics at the Institute for Advanced Study, maintains that the military has good reason to *oppose* nuclear weapons. In fact, he says, "the most interesting jobs for soldiers are nonnuclear. And they will always have something to do."

In his recent Karl Taylor Compton lecture at M.I.T., entitled "Fighting for Freedom with the Technologies of Death," Dyson argued that the assured "technological bloodbath" of post-Hiroshima warfare has made heroism ineffectual and irrelevant and has diminished, even besmirched, the profession of soldiering. His appeal to the military, therefore, is down-to-earth. Their mission is "hedged about with ambiguities," and in trying to justify deployments that are "political rather than military," their jobs have become "schizophrenic." In short, Dyson says, the armed services have been presented with goals that are simply incompatible.

Thus we should encourage a new sort of activism to complement that of the various groups of professionals (scientists, physicians, lawyers) that have lately been organizing against nuclear war: why not captains, colonels, and generals against nuclear war? According to Dyson, soldiers throughout history have refused to employ weapons they considered dishonorable; and military leaders today might gladly trade in nuclear arms for "more practical measures."

And the trade-ins should begin in Europe. "Tactical weapons are much more dangerous than strategic weapons," Dyson says, because they are in places where war may erupt, and because a "first-use" doctrine (permitting nuclear response to a conventional assault) is in effect. This "recipe for disaster," reminiscent of 1914, makes the strategic arms race seem "remote and theoretical." For example, "the MX is stupid," he says, "but doesn't really add to the danger. It is simply a symbol. Our number-one priority should be to change NATO's first-use policy."

An important precedent has been the unilateral U.S. withdrawal of the "Davy Crockett" tactical nuclear missiles from Europe. Next on the list should be nuclear artillery shells—very likely battlefield weapons for countering a Soviet invasion. If these tactical nuclear warheads are ever used in Europe, Dyson predicts an almost-certain escalation, if simulations are any guide, into global nuclear holocaust.

Dyson characterized an army field manual on the employment of tactical nuclear weapons as a "profoundly disquieting document"—a futile attempt to legitimize the illusion that such an assault would differ from a conventional assault in firepower alone. But this may result more from the soldier's willingness to persevere under difficult conditions, political as well as battlefield, than from a military endorsement of tactical nuclear weapons. "When experience is lacking," Dyson remarked, "the handbook writer does the best he can."—*S.J.M.* ☐

Doomsday/Continued from page 8

Suppose the United States had a president who was determined to eliminate national defense as the enemy of national security. What would he do? He could make a ringing declaration to this effect in a document that would take its place among the great documents of human history. He might even issue this document at Gettysburg. Then he might propose to the leaders of the Soviet Union a series of steps to stabilize the system of deterrence now being eroded so rapidly. Even though deterrence is not stable in the long run, it is stable in the short run, and its stability can be increased—that is, the probability of its breakdown diminished. One very important measure would be to discuss how to increase the costs *to the threatener* of carrying out a threat.

. . . with "Guestages"

An ingenious way to do this was suggested to me by Professor J. Kenneth Smail of Kenyon College, a method that he calls "reciprocal hostage exchange." Hostages is an ugly word, but I propose to call this the "guestage program." The United States would host a considerable number—say on the order of 25,000—children, young people, and students from the Soviet Union in schools and colleges in strategic locations, and the Soviet Union would host an equal number of children and young people from the United States. These children would be mainly from the military and the elite in each country. They would each serve two or three years in this capacity, with a number returning home each year and an equal number replacing them.

Communists and capitalists alike love their own children. A "guestages" plan would make it much harder to push the fatal button and would make both unilateral and multilateral disarmament much easier. Furthermore, it would have the long-term effect of strengthening the integrative structure between the Soviet Union and the United States. We might not come to like each other, but we would come to know each other better and to regard each other as a nation of human beings, not merely enemies. The great psychological tranformation that is necessary is the transformation of enemies into opponents. Enemies are not human beings; opponents are.

Along with the "guestages" proposal, we should create a much extended program of scientific and cultural exchange, widespread support of common research institutes such as the International Institute of Applied Systems Analysis in Vienna (one small candle of hope in the present situation that we are preparing to snuff out), and so on.

Even if the Russians did not agree with these proposals, I would then propose a 10-year or 20-year plan for disbanding the U.S. Department of Defense on the grounds that it can no longer defend us—it can only destroy us—and the substitution of a planning agency for civilian resistance to invasion. Invasion would be quite improbable, but improbable events, as indicated above, must be thought about. Probably the most successful national defense organization of the last 300 years has been the Swiss organization. We have to develop a whole new set of social institutions for responding to threat and managing conflict. We can no longer defend ourselves the traditional way—by winning fights. National defense organizations, particularly with the coming of the nuclear warhead missiles, are in the business of genocide.

The old military ethic of courage, fighting, knighthood, and battles is in total ruin, and I doubt whether it can ever be restored. If the military itself is to survive, it must develop a new culture based on ritual and legitimacy rather than on threat. The only monarchs that have survived, as in northern Europe, have done so by renouncing power and becoming symbols of legitimacy. Power is almost as much an illusion as "national interest." Power is corrupting and self-defeating, and national interest is what the nation is interested in. At the moment, our national interest seems to be the eventual destruction of the human race. We could easily turn this around to make our national interest its salvation. ☐

Kenneth E. Boulding is a program director of the Institute of Behavioral Science and distinguished professor emeritus of economics at the University of Colorado at Boulder.

Letters/Continued from page 2

☐ The Soviet Union is not a "minor naval power," nor is its navy's main capability "limited sea denial." With an attack and guided-missile submarine force of almost 300 ships (compared with the U.S.'s 87), the Soviet Navy poses an enormous threat to the seaborne reinforcement of Western Europe in the event of war.

☐ Battlefield tests of Soviet weapons have not shown them to be of poor quality. One example is the 1973 Arab-Israeli war, where Soviet-made SA-6 low-altitude antiaircraft missiles shot down 30 Israeli aircraft in the opening stages of the conflict.

☐ Mr. Johnson ignores those aspects of Soviet military capabilities that far surpass U.S. capabilities and thus potentially nullify other areas in which the U.S. enjoys an advantage. For example, Soviet chemical warfare forces outnumber U.S. forces by 20 to 1. Over 20 percent of the Soviets' conventional munitions stockpile consists of chemical weapons, and they have at least two facilities actively engaged in producing chemical weapons. The U.S. has none.

The most disturbing aspect of Johnson's article is his underlying assumption that because the Reagan administration overstates the severity of the Soviet threat, it is only fair for critics to understate the threat. This attitude resembles the arms race itself, with critics escalating their hyperbole to counter hyperbole from the other side.

Richard A. Guida
Alexandria, Va.

Michael Johnson responds:
Though I apologize for the oversight of including 10 decommissioned Polaris submarines in the U.S. strategic forces, my point remains unchanged. Having personally fired most army weapons, qualified tanks, attended airborne and range schools, served on battle and planning staff, and attended West Point, I am convinced that American equipment is more than adequate. I have also watched Israeli defense forces use the same equipment and achieve spectacular results at far worse odds than the United States will ever face. The problem facing the U.S. armed forces is chiefly one of personnel quality.

A Thought on the Penny

Rather than making the penny out of zinc instead of copper (*"Penny Wise," February/March, page 80*), we should abandon it altogether. Since practically nothing can be bought for a penny anymore, this will certainly happen soon, and we could save about $40 million in minting costs.

Larry Penberthy
Seattle, Wash.

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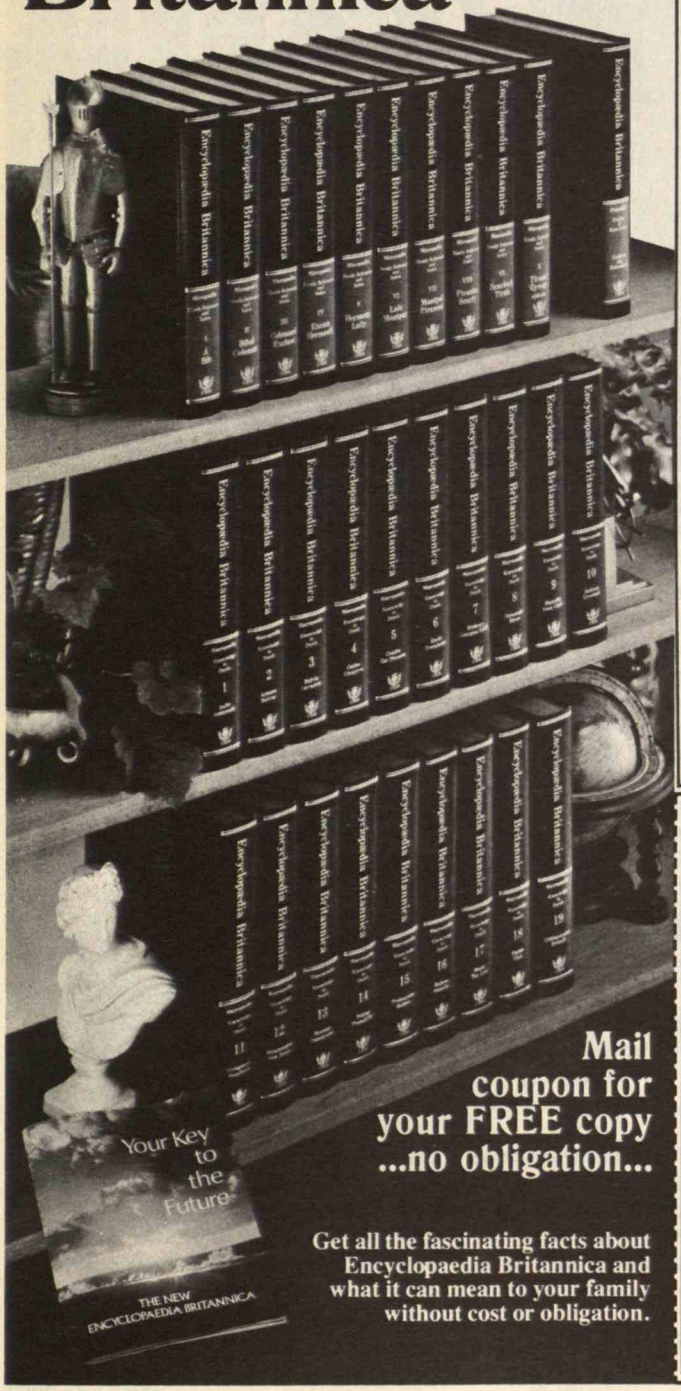
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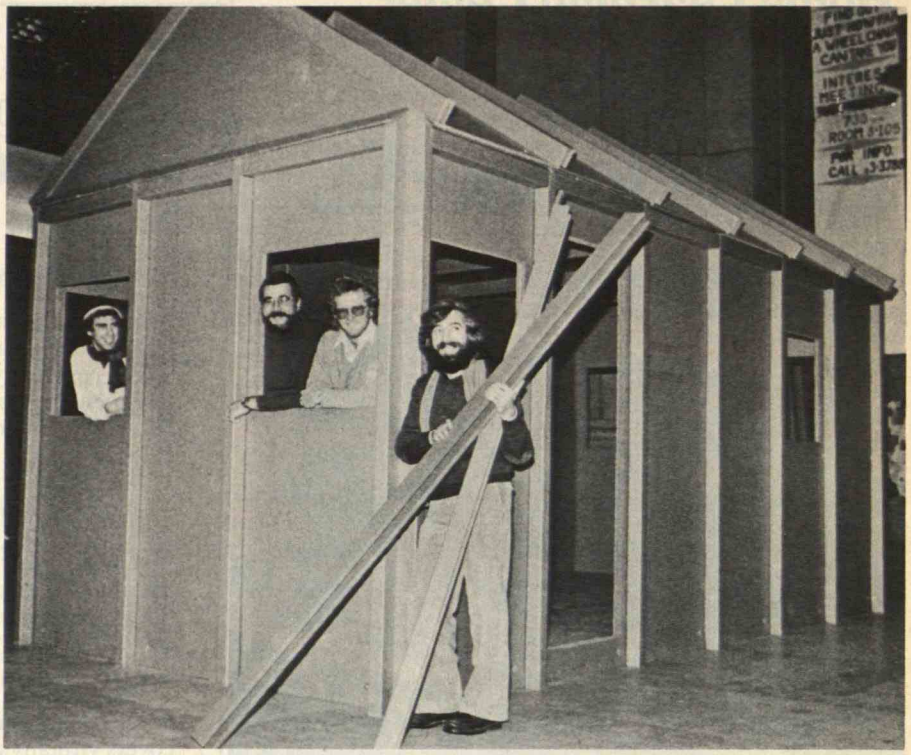
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M.I.T. REPORTER

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. . . layers of corrugated paper, that is, glued together and then cut to form roofs, walls, and doors. A paper structure is light in weight and easy to build—just what's needed for emergency housing following a major fire or other disaster, says Jose de Prada Poole, lecturer in architecture at M.I.T. The cost of a basic one-room unit: $2,500, thinks Mr. de Prada. Since the units are modular they can be combined into larger dwelling units, and Mr. de Prada thinks that permanent materials—bricks, plaster, and wood—could be added to make the temporary housing permanent. ☐



Architect Jose de Prada (right) and three M.I.T. graduate students designed and built this "cardboard house" late last year. They're serious about it: light in weight and easy to erect, such houses of corrugated cardboard could be invaluable emergency shelters for victims of major catastrophe, says Mr. de Prada.

Summer Short Courses

One-to-three-week short courses on more than 50 timely topics in technology will be given during the coming summer at M.I.T. Included: computer music, chemical process control, modular software, personal computers, control theory, speech communication, man-machine interfaces, shipping management, lasers and optics, biotechnology, productivity and manufacturing management, and strategic corporate planning. Tuition ranges from $650 upward, with moderately priced accommodations available in M.I.T. dormitories.

For a complete list of offerings: Director of the Summer Session, Room E19-356, M.I.T., Cambridge, Mass. 02139 ☐

Ultrasound to Measure the Soundness of Bone

A simple, quick, and painless technique for assessing the strength of bones in living creatures is reported by Professor George W. Pratt of the Department of Electrical Engineering and Computer Science. It's based on his finding that the speed of ultrasound through a bone correlates with the bone's strength and integrity.

Experiments with horses, Professor Pratt explains, show that rapid sound propagation indicates a strong bone, and that lower velocities are characteristic of bones that have been weakened by stress.

Persistant stresses to a bone may lead to microscopic fractures, and it is those which Professor Pratt is detecting. In horses, such fractures are common in the metacarpal bone, in the front of the foreleg below the knee; they cause a painful condition known as "buckled shins," not unlike the "shin splints" common in runners. Some 80 percent of all race horses suffer from this problem, and Dr. Pratt's long-time interest in horses led him to seek a way to detect this condition in its early stages.

Now Dr. Pratt is using his technique to study the effect of drugs on bone strength—especially those drugs used to alleviate pain. ☐

Disparities to Grow

The southeast, south central, and Rocky Mountain regions of the U.S. will grow fastest between now and 1990, with New England and the northwestern plains a close second, says a new study by the M.I.T.-Harvard Joint Center for Urban Studies.

Three new trends found in 1980 census data spark the JCUS forecast:

☐ Fertility patterns are dramatically different in different parts of the U.S.

☐ Migration patterns have replaced births and deaths as the major determinant of population growth.

☐ The nationwide shift from metropolitan to nonmetropolitan growth will continue.

Taken together, these trends tend to reinforce each other. Thus, the JCUS study foresees increasing regional disparities in the U.S. by 1990—and therefore growing policymaking difficulties at the national level for the coming decade. ☐

NATO Nuclear Alternatives

How can conventional military forces and armaments be most effective in NATO's efforts to offset Soviet military strength?

Carroll L. Wilson, Mitsui Professor in Problems of Contemporary Technology, emeritus, at M.I.T., has now organized a major two-year international study of this question. The goal, he says, is to find how the effectiveness of conventional weapons can be maximized to reduce the likelihood that nuclear weapons will be used. The European Security Study (ESECS), with headquarters at the American Academy of Arts and Sciences in Cambridge, will produce a series of papers during 1982-83 and a final report early in 1984. An international steering group is now being formed. ☐

From Shortage to Surplus?

Today's shortage of engineers—if indeed there is one—is likely to be short-lived, replaced by a surplus in less than half a decade, says Professor J. Herbert Hollomon, director of M.I.T.'s Center for Policy Alternatives.

The supply of engineers is cyclical, he says. High-school students can read the papers just like the rest of us, and they flock to engineering schools because they read about high salaries and plentiful jobs for engineers.

But the students who are now crowding U.S. engineering schools are likely to swamp the market as they graduate in the mid-1980s, says Dr. Hollomon, and instead of a shortage there will suddenly be a surplus—barring, that is, some massive infusion of demand from an unexpected military or space program. □



CALVIN CAMPBELL

Dr. John F. Burke (left) of Massachusetts General Hospital and Dr. Ioannis V. Yannas (right) of M.I.T. are shown with a sample sheet of a new artificial skin that induces growth of a permanent, functionally acceptable new skin.

A New Artificial Skin

The biomedical engineering team that first developed artificial skin for burn victims has now reported progress with an improved version that appears to induce a permanent, functionally acceptable new skin.

The new skin substitute—the researchers call it a "template" because it guides new growth—is seeded with basal skin cells taken from the individual who is to receive the skin substitute. The seed cells grow into a new epidermis. In this way healing is speeded, scarring is reduced, and the need for later epidermal grafts is eliminated, says Ioannis V. Yammas, professor of polymer science in the Materials Science Department. □



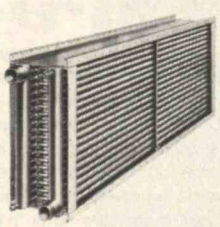
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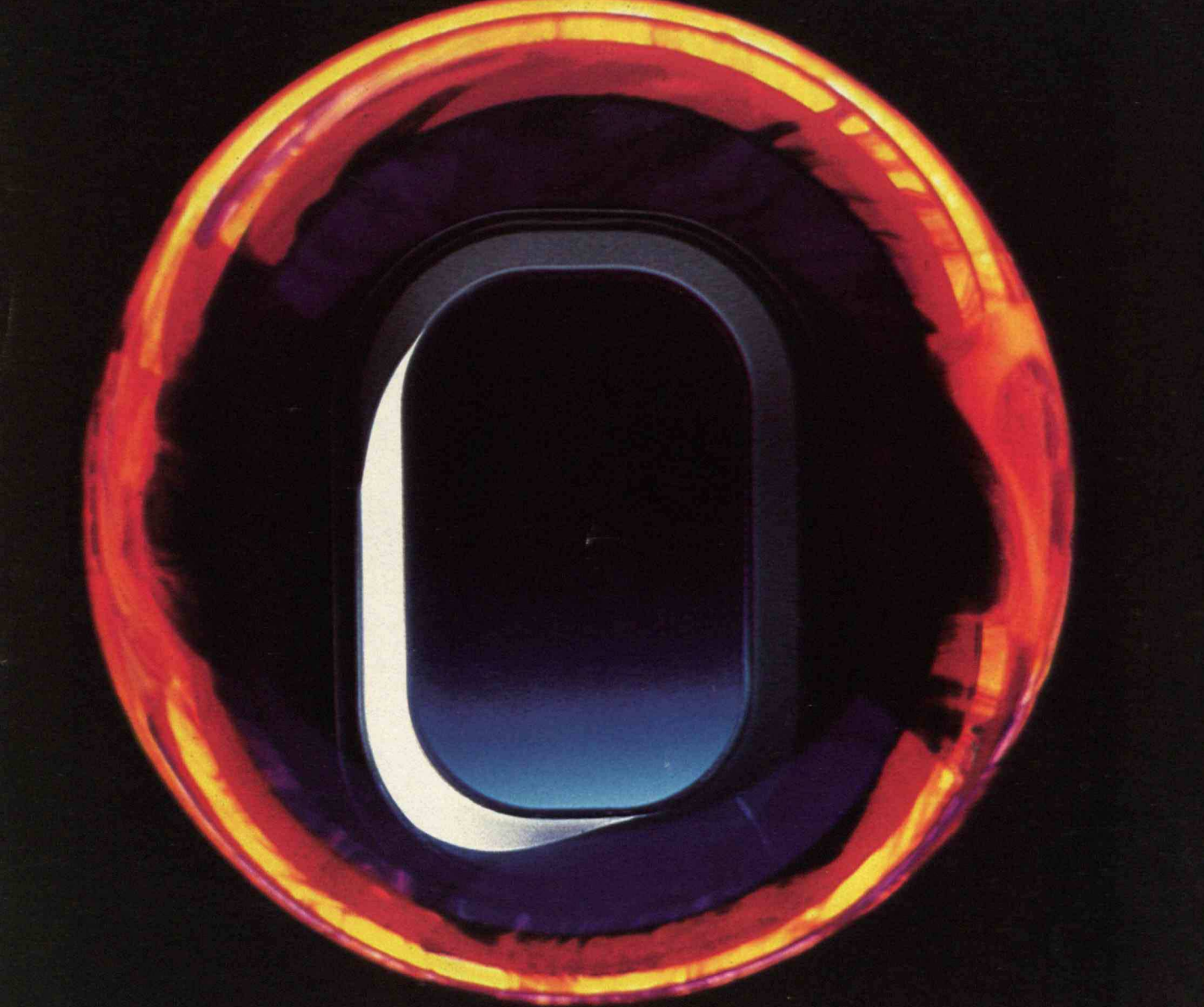
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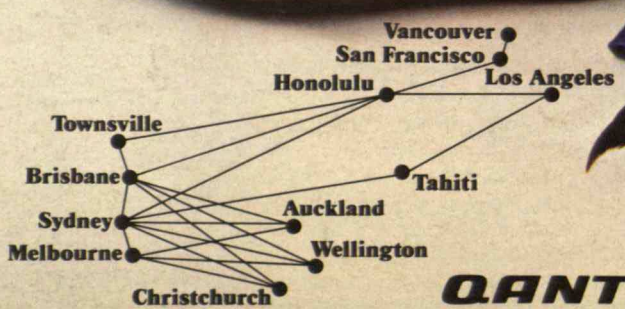
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